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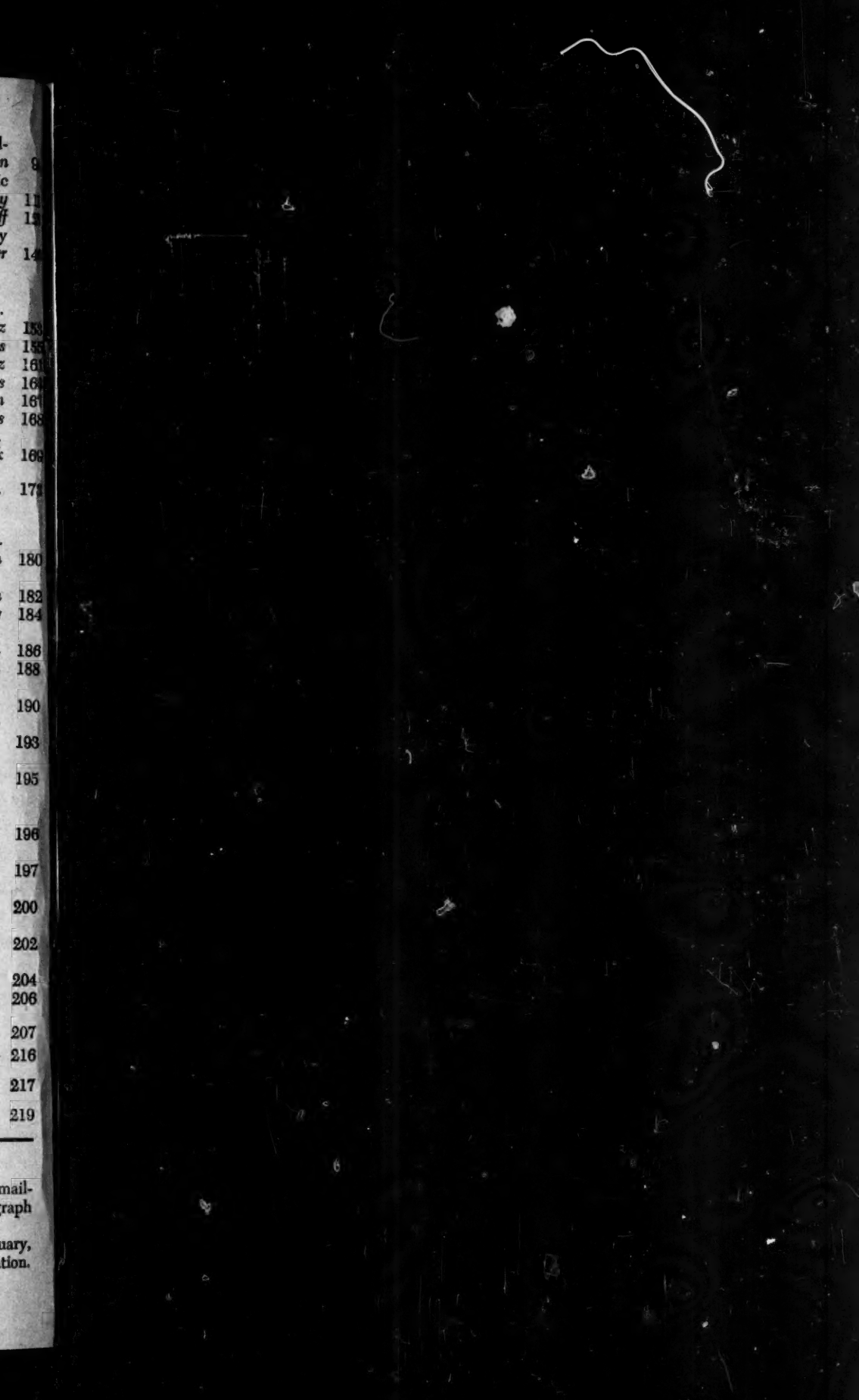

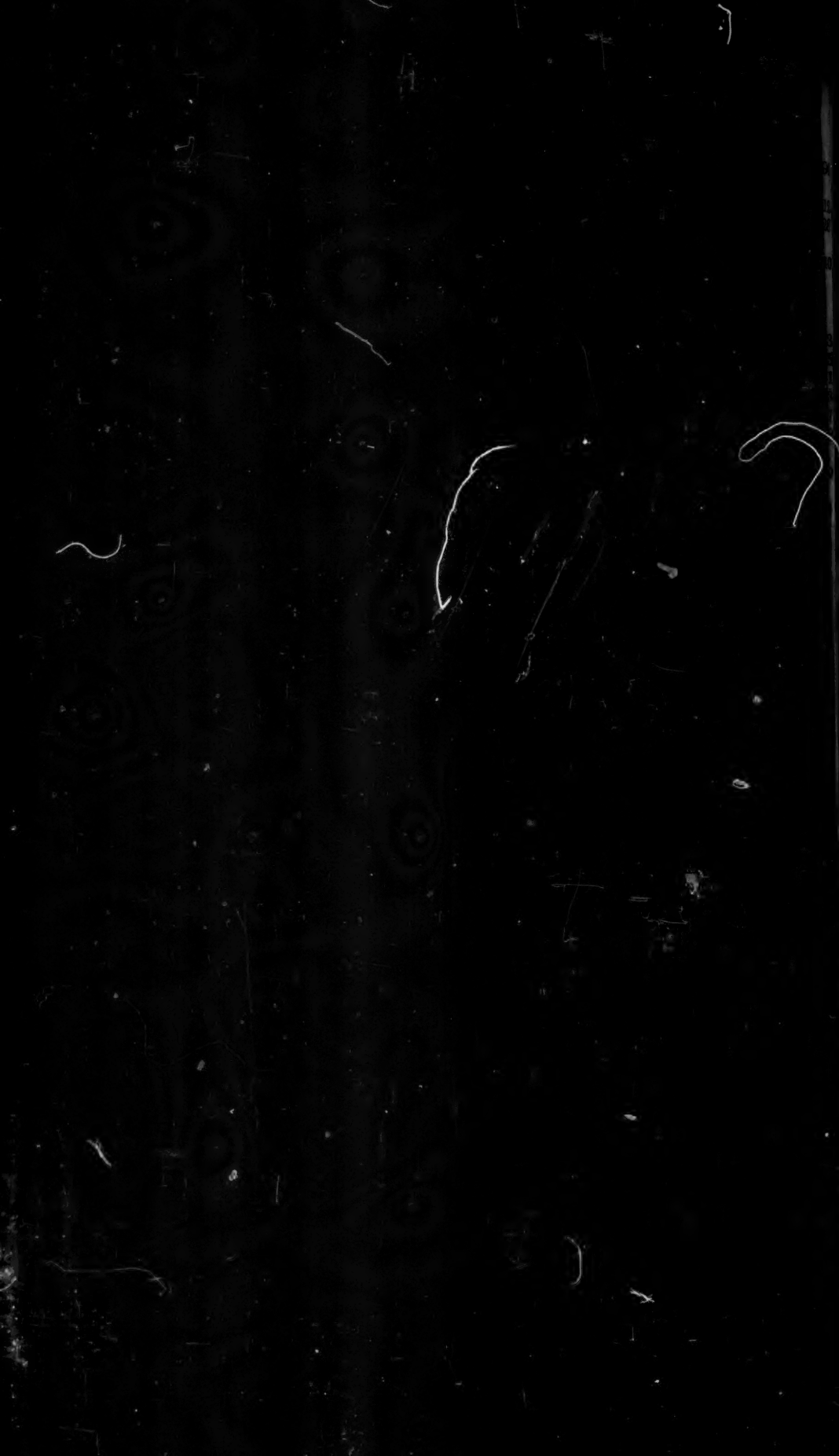

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JOURNAL
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CARICATURE AND THE ORIENTATION OF AGRICULTURAL ECONOMICS

ROGER W. GRAY
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GALBRAITH'S latest tirade against agricultural economists[1] may elicit a sigh of relief from the profession. Having chronicled earlier the course of its fatal disease, and now written its obituary, what more can he say? Let us not beg the question; he can celebrate a prolonged wake or frequent reinterments and perform endless autopsies, having indeed already delved into the *post mortem* in other contexts under such prophetic titles as "What To Do After the Undertaker Comes"[2] and "To the Last Man, to the Final Shot."[3] But the sigh of relief would have been premature for idiomatic reasons anyhow, for none can tell whether Galbraith has written *ex ante* or *ex post*, his bedside manner being indistinguishable from his funereal. Death differs from life only in degree in the Galbraith idiom, in which an unlimited supply of adverbs may be called upon in resisting the dichotomy—we may be temporarily, seemingly, unhappily, obviously, or even admittedly dead, but we'll never be dead dead. Galbraith, then, will return to the pages of the *Journal*, and interested readers may be expected to witness the continuing spectacle of his challenging allegations going unnoticed by those against whom they are directed. The premise that material published in the *Journal* merits the consideration of readers may weaken the pretense that Galbraith does not exist, but we have yet to admit that the king is wearing no clothes.

It occurred to me when I read the three policy articles in the May, 1955

[1] J. K. Galbraith, review of Murray R. Benedict, *Can We Solve the Farm Problem*, *Journal of Farm Economics*, Vol. XXXVIII, 3, August, 1956.
[2] *The Reporter*, Nov. 4, 1954.
[3] *The Reporter*, Jan. 13, 1955.

issue of the *Journal*[4] that a matter deserving of attention is reflected here; namely, the impact of an encroaching intensional orientation in the profession upon its younger members. Galbraith's current advice to younger members is the more welcome as providing evidence that awareness of some such impact is not lacking on his part, and as a reminder that further evidence of the impact and of some concern over it has been accumulating. I doubt, however, if those who have spotted the impact are in agreement as to its source, in which case their concern is not apt to fructify. This impact, it seems to me, has been that the younger and potentially more productive economists have lost interest in the broad policy question. For reasons other than lack of the glass-top desks which Galbraith imputes to them, they have not placed his dictums on their desks. Instead, as they have watched the broad policy questions become mired in the sterile quicksand of political semantics, they have taken refuge on the high ground of computational technique. Policy issues give place in the *Journal* to geometry, breadth to finesse, and the ineluctable flight of a notoriously shirtsleeved profession toward esotery proceeds apace. The past president of the association has expressed concern over the trend,[5] incognizant of the possible contribution his own impassioned pleas[6] may have made to the emergent stalemate. This trend is not, be it noted, a reaction to the politics or general divisiveness of the farm problem, nor is it the result of discouragement over the sheer complexity of the problem. The refusal of younger economists to engage the major policy issues springs directly from the fact that a stigma attaches to the discussion; a stigma which owes as much as to any other source to the willingness of the leading members of the profession to allow Galbraith's caricature of them to stand.

I shall attempt to illustrate here, by drawing mostly from the May, 1955 issue of the *Journal*, the perhaps obvious proposition that Galbraith is a master of caricature and that outstanding agricultural economists ignore the caricature. I shall argue further that most younger economists do not find the resultant hiatus conducive to the broad approach which Brandt misses. I shall conclude with some modest recommendations aimed at facing the problem.

[4] Earl L. Butz, "The Agricultural Economist in the Political Environment of Policy Making"; J. K. Galbraith, "Farm Policy: The Current Position"; and Geoffrey Shepherd, "What can a Research Man Do in Agricultural Price Policy?" *Journal of Farm Economics*, Vol. XXXVII, 2, May, 1955. While I do not attempt to review these articles here, I hope that they will be reread.

[5] Karl Brandt, "The Orientation of Agricultural Economics," *Journal of Farm Economics*, Vol. XXXVII, 5, December, 1955.

[6] See, for example, that quoted by Galbraith in "Economic Preconceptions and the Farm Policy"; *American Economic Review*, Vol. XLIV, 1, March, 1954, p. 44.

II

Perhaps the clearest view of Galbraith's article as caricature is obtainable by sketching it in caricature. The all too Luce-id prose style which is his chosen form of expression portrays events, relationships, and facts, as well as personages, in caricature. He abjures statistical estimate in favor of such estimates as "notable," "truly mammoth," and "formidable," for which the standard error may be given as "not always undiluted."' He adverbializes the language by employing the "ly" suffix; the "ly"-ing propensity runs in excess of ten instances per page in the May, 1955 article, which reads about typical. Many of these "ly's" are subjective; for instance "outrageously," "punishingly," "unhappily," "unpleasantly," "agreeably," "ardently," "oddly," and "gracefully;" while an important subclassification includes those which connote Galbraith's lofty vantage point; for instance "easily," "only," "readily," "simply," and "merely"—words occurring fourteen times in the article. In "readily establishing," "ardently defending," "strongly affirming," "agreeably characterizing," or "deeply justifying," the "wholly hypothetical," "admittedly invisible" and even the "outrageously unpopular" (however, "inherently salutary") he would rely upon "the present habit," "the national supposition," the "wide agreement," the "weight of rational expectations," "the detached and scientific view," and, of course, the "obvious." Caricature begets caricature; yet Galbraith, in the article here subjected to semantic caricature, deplores the "political semantics" of the farm policy discussion.

III

In order to be effective, caricature must have a referent. If we now view the Butz article in the same issue, as it lends itself to Galbraith's artistry, we find that it serves the purpose. A few statements selected from the two articles suffice to illustrate the point.

Butz	Galbraith
"What the administration decides to do with their [pure economists'] analysis is quite another thing" (p. 195).	"In writing the new farm program it [the administration] obviously regarded the judgments of social scientists as dispensable" (pp. 296-297).
"Who among us can deny that some sincere schoolmaster who taught Ezra Taft Benson the value of free institutions and personal integrity exerted a tremendous influence on agricultural policy in 1954?" (p. 196).	"until farm policy is approached in simple, non-theological terms of problems and solution I doubt that we will make any progress" (p. 298).

"If we believe there is merit in relatively free economic institutions in our society . . ." (p. 196).

"this process made it easier for a vigorous Secretary of Agriculture with the courage of his convictions to 'sell' . . . the new philosophy of price support . . ." (p. 193).

"Free markets . . . are no more useful or appropriate goals than ninety per cent of parity" (p. 298).

"It cannot be too strongly emphasized that faith without the requisite elasticities is not enough" (p. 295).

I have not set out here to discuss the economics of this or any other administration's approach to the farm problem. The paired quotations simply illustrate my point that leading agricultural economists contribute to the persistence of the Galbraith caricature. Statements of the sort quoted here from Butz are beyond the reach of economic analysis, but they are within the reach of caricature.

IV

The essence of Galbraith's caricature is the "preconception" of economists that the free market is best. It is difficult to know whether someone is harboring a preconception; the allegation is more easily made than proved; more easily ignored than disproved. It is one thing to say that a man has a large nose and another thing to say that he has a sinister smile. The run-of-the-mill caricaturist will exaggerate the features; the expert will more carefully draw the smile. There is no question but what many agricultural economists have expressed confidence in the workings of free markets. Whether the expression as such is a qualified conclusion drawn from observation or an article of faith drawn from economic theory is as difficult to prove as whether a peculiar smile is benign or sinister. Given the smile, the expert caricaturist can lend it either interpretation; *only* caricature, in fact, can alter its interpretation.

The Shepherd article in the same *Journal* issue is unwonted and probably unconscious caricature, but it is caricature nonetheless and it is important to the present argument because it contains in embryonic form the rationale of the younger economists' retreat toward mathematics. It is caricature in that Cochrane, Mitchell, and Schickele are accused of working from preconceptions, just as the Galbraith caricature accuses Brandt, Schultz, Butz and various others of working from preconceptions. Shepherd's caricature is crude and lacking in vigor as compared with Galbraith's, but Shepherd is only dabbling in caricature while Galbraith has held major exhibits. Shepherd, for example, makes Schickele suffer by comparison with Galileo, who refused to be swayed by popular beliefs about the Earth's motion, while Schickele allows beliefs about farm tenure to guide him. The social and the natural order are not distinguishable in Shepherd's caricature.

The convenient juxtaposition of the two caricatures in one issue of the *Journal* offers opportunity to underline my thesis. Galbraith has found the leading economists guilty of harboring preconceptions. Shepherd, in his turn, while not quite finding Galbraith guilty of the same crime, in so finding Cochrane has convicted the one agricultural economist who has received Galbraith's footnote acquittal.[7] This does not resolve nor even join issues; it only clouds them. Both Galbraith and Shepherd caution their readers against abstractions, both endorse the problem-solving approach associated with the writings of John Dewey, yet the dominant impression to be gleaned from either article is the caricature of others.

Out of a complex in which words with strong affective connotations are so liberally used (as in the Butz article), in which the power of words is exploited to create the major "preconceptions caricature" (as in the Galbraith article), and in which a minor "preconception caricature (Shepherd's article) is the closest approach we have seen to recognizing the existence of the major one—out of such a complex came the orientation in agricultural economics which Brandt decried in his presidential address. The failure which has led toward an overemphasis upon mathematical technique has been a communications failure. The full measure of our dilemma can be appreciated only in recognizing that while Brandt and others have voiced the concern that mathematics is an unduly restrictive means of communication, *mathematics has been increasingly embraced as the only satisfactory means of communication because other means have been misused.*

V

It seems to me that there are a number of ways in which responsible economists might gradually remove the stigma that attaches to policy study. I should say first that my reaction to Shepherd's prescription on policy study is that it is too restrictive and sanguine because it visualizes economists in the role of natural, experimental scientists. Although his concern is a proper one, I fear that his prescription may do more to rationalize than to lessen the present emphasis on computational technique. He quotes Dewey approvingly as saying that "thinking begins in what may fairly enough be called a 'forked-road' situation;"[8] a philosophy I would not dispute but would only qualify by saying the thinking ends of the "forked-road" consists of two sawdust trails.

If my insight into the problem is clear, we need first to make allow-

[7] *Op. cit.*, N. 28 and 29.

[8] Shepherd, *Op. cit.*, p. 314, quoted from John Dewey, *How We Think*, New York: D. C. Heath and Co., 1910, p. 11.

ance for the effectiveness of caricature. It seems little enough to expect of the long list of intellectually honest scholars who stand at the top of the profession that they give over playing such willing foils to the caricaturist. At a minimum they could rid their vocabulary of the slogans, directive terms, and empty generalizations that riddle their writings to his unending delight. If the mustache is the focal point of the caricature, go home and shave it off.

To the extent that the caricature draws heavily upon the seeming "superficiality" of terminology, this would do much to undermine it and to demonstrate that terminology is less superficial than it sometimes seems. But a more important recommendation is that it be recognized and dealt with openly. Some may argue that dignity demands that the caricature be ignored, to which I object that an ostrich with his head in the sand is the least dignified of creatures. Galbraith's accusations are not less serious because they are carried in his unique idiom, and those who are accused of reasoning from preconceptions or predilections for a cause would do well to examine the extent to which this is true and to answer such arguments as they deem inconclusive, unsupported, unfair, or false. Galbraith is a qualified critic and a skilled caricaturist; leading agricultural economists are no more entitled to neglect the criticism just because it is clothed in caricature than Galbraith is entitled to neglect their analysis just because it is obscured by slogans. In stalemate it is nobody's move, but the greater degree of objectivity and the greater confidence in the result is exhibited by the one who, anticipating stalemate, moves to avert it. For the essence of the matter is that no one of us, as a social scientist, is or can be completely objective. The highest attainable degree of objectivity for our profession is that which results from a continuing interplay of ideas and a continuing willingness to confront our ideas, not alone with facts, but with the criticisms of others. The aspiration toward complete objectivity through accumulation of all the facts is a delusion; any thought that mathematics provides a short cut to this complete objectivity is delusion compounded. The objectivity of our profession is but enhanced by the determination of pertinent facts and the use of the most powerful methods for their collation, as it is but undermined by ignoring criticism or distorting facts. The time when communications are better established within our profession, when criticisms are acknowledged and caricatures lived down, will be soon enough to worry about the drift toward mathematics. This drift is not our communications problem; it represents more nearly an attempt to solve or to escape the communications problem. When there is brought to the major policy discussions a higher respect for the

role of criticism, both by the critics and the criticized, the spectre of mathematical obscurantism will have vanished.

There would be too many who think that I mistake or oversimplify our problem to justify any attempt on my part to specify a detailed solution or to spell out my view of the problem in greater detail. Those who think I have overdrawn a caricature of my own will have done my argument full justice by reconsidering recent policy writings in the light of my caricature.

SPECIFICATION BIAS IN ESTIMATES OF PRODUCTION FUNCTIONS*

ZVI GRILICHES
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I. *Introduction*

IT IS common in empirical work to compromise and use second-best methods or variables. Sometimes we may know what we want, but even then it may be impossible to get it. Either there are no pertinent data, or the variables are nonmeasurable, or our budget and computational facilities are limited. Hence we exclude variables, accept approximations, aggregate, and commit various other sins of omission and commission. The statisticians call these "specification errors." In this note, I shall attempt to describe a method of ascertaining the consequences of some of these compromises. If we know their effect upon our results, we may be better able to interpret our results.

First, I shall outline a general framework, which has been developed by Theil,[1] for dealing with these kinds of problems and then apply it to some common specification errors in Cobb-Douglas production-function[2] estimation. In particular, I shall devote special attention to the bias that arises in the estimate of returns to scale. I shall use the usual definition of returns to scale as the sum of the coefficients in the Cobb-Douglas production function. This sum, $e = \sum a_i$, is often called the "elasticity of production" or "function coefficient."[3]

It will be shown that we underestimate returns to scale if we exclude an input that varies less than proportionately with the included inputs, and vice versa. I shall also show that under "reasonable" assumptions the omission of managerial inputs from the production function biases the estimate of the elasticity of output with respect to capital inputs upwards and the estimate of returns to scale downwards. The disregard of quality differences in our measures of labor leads to an upward bias in our estimate of the elasticity of capital inputs, downward bias in the estimate of the elasticity of labor inputs, and to a downward bias in the estimate of returns to scale. Also, it is suggested that if we believe in Cobb-Douglas functions, we should

* I am indebted to Professor T. W. Schultz for suggesting this problem to me and to Professor H. Theil for the tools used in this paper. This paper was written during my tenure as a Research Training Fellow of the Social Science Research Council.

[1] H. Theil, "Specification Errors and the Estimation of Economic Relationships," unpublished mimeographed paper, Chicago, 1956.

[2] $\log y = a_1 \log x_1 + \ldots + a_k \log x_k$.

[3] For a more general definition of "e" see Sune Carlson, *A Study on the Pure Theory of Production*, London, 1939, p. 17. "e" will measure returns to scale only if all factor prices are independent of scale and (which may or may not be the same thing) if the firm can in fact vary all the factors of production proportionately. The results of this note will emphasize the importance of this restriction. See part IV of this note.

use geometric averages and sums when we aggregate our inputs rather than arithmetic ones as is commonly done. If we do so, there will be no particular tendency towards bias unless there is a strong association between the individual elasticities and the levels of the corresponding inputs, but our estimates become quite shaky. Even if we use arithmetic sums, this may not lead to bias (except in the constant term) if the inputs that we we aggregate are used in approximately fixed proportions.

Those who are interested in the particular results rather than in the general method, and do not like mathematics, may skip the following section. However, they shall miss the "meat" of this note which is a method for dealing with a much wider range of problems than I shall be able to take up here. The particular results are consequences of various assumptions, while the method is neutral. You may plug in your own assumptions and crank out the results.

II. *The Framework*[4]

Consider the general problem of multiple regression:

$$y = Xa + u \tag{1}$$

where y is a column vector of values taken by the dependent variable, X is a matrix of values of all the independent variables, a is the column vector of parameters we want to estimate, and u is a column vector of disturbances with zero expectation.[5] This is what we believe to the "true" relationship in the population. However, for various reasons, we are not going to use X but $\overline{X}$ in our estimation procedure, where $\overline{X}$ is a different matrix of independent variables. $\overline{X}$ may contain completely different values than X, it may be equal to X except that it has one column less than X, or each of its columns may be a sum, a product, or some other combination of various columns in X. Both X and $\overline{X}$ are assumed to be non-stochastic. Instead of estimating (1), we estimate

$$y = \overline{X}\bar{a} + \bar{u} \tag{2}$$

What is the relationship between the estimates of $\bar{a}$ and the "true" parameters a. Assume that we estimate $\bar{a}$ by the method of least squares. Then the estimate of $\bar{a}$, let us call it b,[6] will be given by

$$b = (\overline{X}'\overline{X})^{-1}\overline{X}'y \tag{3}$$

[4] This framework was developed by Theil, *op. cit.* See also H. Theil, *Linear Aggregation of Economic Relations*, North-Holland Publishing Company, Amsterdam, 1954.

[5] For an introduction to matrix algebra see the Appendix of L. R. Klein, *A Textbook of Econometrics*.

[6] This is the solution of the "Normal Equations" in matrix notation. For a presentation of least squares in this notation, see R. Stone, *The Measurement of Consumers' Expenditure and Behavior*, Vol. I, Cambridge University Press, 1954, 280–291, and O. Kempthorne, *The Design and Analysis of Experiments*, John Wiley and Sons, 1952, 54–67.

Substituting (1) in (3) and taking the expectation of b, we get

$$E(b) = E(\overline{X}'\overline{X})^{-1}\overline{X}'(Xa + u) = (\overline{X}'\overline{X})^{-1}\overline{X}'Xa. \tag{4}$$

Let $(\overline{X}'\overline{X})^{-1}\overline{X}'X = P$, then

$$E(b) = Pa \tag{5}$$

and we have expressed the expectation of our estimates in terms of the parameters of the true specification. Each of our estimates is a weighted sum of *all* the parameters in the true specification. However, we may be able to say something about these weights, and therein lies the usefulness of the method.

If we look at the formula for P it can be seen that the elements of P can be thought of as coefficients in a set of regressions. They are the coefficients in the regression of each column of X on $\overline{X}$; that is, they are the coefficients of the least squares regression of each of the "true" variables x on all of the included variables $\bar{x}$. For example, the i-th column of P will be composed of the least squares coefficients in the regression of the i-ith "true" variable on all the variables included in the actual estimation procedure. They will come from the following "auxiliary" regressions:

$$x_i = p_{1i}x_1 + \ldots + p_{hi}x_h + v_i \tag{6}$$

where the v's are the least squares residuals in that regression. Hence the impact of the various true parameters on the estimate of the coefficient of a particular variable will depend on the size and magnitude of the coefficients attached to that variable in the various "auxiliary" equations. If it is possible, in particular instances, to use some outside knowledge and specify the sign and magnitude of the various p's, it is then possible to arrive at conclusions about the sign and magnitude of the bias in our estimates.

To summarize this section briefly in words we can say that, if we know what the true equation should look like but we estimate something different from it, it is possible to express the resulting coefficients in terms of the coefficients of the true equation. Each of the estimated coefficients will be a weighted sum of *all* the coefficients in the true equation. The weights will be the coefficients in the "auxiliary" regressions of each of the true variables on all of the variables included in the estimated equation. That is, they will depend on the interrelationship *in our sample* between what we want and what we observe or actually use. If we want to make concrete statements about the bias in our estimates, it is most important to be able to say something about these interrelationships or "weights."

III. *The Omission of a Relevant Variable*

If we omit a relevant variable which is uncorrelated with the other independent variables included in our analysis, the omission will not bias the

estimates of the parameters of the included variables. But even in this case we shall have a biased estimate of e, the returns to scale. Under the usual assumptions about the coefficients of production functions ($a > 0$) our estimate of e will be biased downward, and the bias will be equal to minus the coefficient of the excluded variable.[7]

However, the assumption of no correlation between the excluded variable and all the included variables is hardly tenable for factors of production. A more plausible assumption is that there is some positive correlation between the excluded variable and some of the included variables. This will bias the estimate of at least one of the coefficients upward, but it is not clear if it will be enough to compensate for the downward bias in our estimate of e due to the omission of the coefficient of the excluded variable. We shall use the framework outlined in section II to answer this question.

If we exclude the variable x_k from our analysis, the expectation of the estimates of the included coefficients is given by:[8]

$$E(b_i) = a_i + p_{ik}a_k \tag{7}$$

where, in the case of a Cobb-Douglas function, the P's come from the following regression:

$$\log x_k = p_{1k} \log x_1 + \ldots + p_{k-1,k} \log x_{k-1} + v. \tag{10}$$

That is, the p's are the coefficients in the regression of the logarithm of the excluded variable on the logarithms of all the included variables.

The sign of p_{ik} will determine if a particular b_i will underestimate or overestimate the corresponding true parameter a_i (it is assumed that $a_k > 0$). The sign of p_{ik} will depend on the actual distribution of all the x's in a particular sample. Although a negative association of x_k with some of the x_i's is possible, for factors of production a positive association is more plausible. Hence, if we exclude some factors of production from our regression, we shall on the average overestimate at least some of the coefficients of the included variables.

[7] If x_k is the excluded variable, if the b's are the estimated coefficients, and if $\hat{e}$ is the estimate of the elasticity of production, then

$$\hat{e} = \sum_{i=1}^{k-1} b_i \quad \text{and} \quad \text{Bias} = E(\hat{e} - e) = E\left(\sum_{i=1}^{k-1} b_i - \sum_{i=1}^{k} a_i\right)$$

$$= \sum_{i=1}^{k-1} a_i - \sum_{i=1}^{k} a_i = -a_k.$$

[8] $\overline{X}$ is equal to X except that the last column is excluded. There is only one non-trivial "auxiliary" regression, that of x_k on all the included variables. The coefficients in all the other "auxiliary" regressions are one in the case of the coefficients attached to the corresponding variables, and zero in the case of the coefficients attached to the non-corresponding variables. The P matrix can be partitioned into an identity matrix and a column vector of the coefficients of the only non-trivial "auxiliary" regression: (8) $P = [I\ p_k]$ and hence (9) $E(b) = a + p_k a_k$, where the vector a has $k-1$ elements.

However, we are interested in what happens to our estimate of returns to scale,

$$\hat{e} = \sum_{i=1}^{k-1} b_{iu}$$

the sum of the estimated coefficients, as compared with the true returns to scale,

$$e = \sum_{i=1}^{k} a_i,$$

the sum of the coefficients in the true production function. It can be shown that the bias in our estimate of returns to scale will be equal to[9]

$$E(\hat{e} - e) = a_k\left(\sum_{i=1}^{k-1} p_{ik} - 1\right) \tag{11}$$

That is, whether we underestimate or overestimate returns to scale will depend on the sum of the coefficients in the "auxiliary" regression. We will underestimate e if this sum is less than one, there will be no bias if it is exactly equal to one, and we will overestimate e if this sum is larger than one.

$$\text{If } \sum_{i=1}^{k-1} p_{ik} \gtreqless 1 \text{ then bias} \gtreqless 0 \tag{12}$$

A very simple interpretation of this sum of coefficients is possible in the "auxiliary" regression. These are coefficients in the following Cobb-Douglas-like equation:

$$x_k = x_1^{p_1} x_2^{p_2} \cdots x_{k-1}^{p_{k-1}} e^{v} \tag{13}$$

The sum of the p's is then equivalent to the "elasticity of production" or "returns to scale" in this particular "auxiliary" regression. The bias in our estimate of returns to scale will depend on how x_k changes in the sample when all the other x's are varied to scale. We shall underestimate e if proportional changes in the included inputs are associated with less than proportional changes in the excluded variable *in our sample*. There will be no bias if the excluded variable varies on the average in the same proportion with proportional variations in all the included variables. We shall overestimate returns to scale if the excluded variable varies more than proportionally with the included variables in our sample. Whichever is true will

[9] $$E(\hat{e} - e) = E\left[\sum_{i=1}^{k-1} b_i - \sum_{i=1}^{k} a_i\right] = \sum_{i=1}^{k-1} (a_i + p_{ik}a_k) - \sum_{i=1}^{k} a_i$$
$$= \sum_{i=1}^{k-1} a_i + a_k \sum_{i=1}^{k-1} p_{ik} - \sum_{i=1}^{k} a_i = a_k\left(\sum_{i=1}^{k-1} p_{ik} - 1\right)$$

depend on the particular sample at hand and its distribution of the included and excluded x's.[10]

The specification error conceded most often by estimators of production functions is the omission of entrepreneurial or managerial services.[11] Whether inputs of managerial service or entrepreneurship increase proportionately or not with the other inputs is a question of fact that cannot be answered here conclusively. However, while it is reasonable to assume that certain supervisory functions will increase proportionately with total inputs, it does not seem reasonable that decision making and planning, which account for a substantial share of these inputs, will also increase proportionally. It is probably true, in most of our samples, that a farmer who farms on twice the scale of his neighbour is not twice as good an entrepreneur, nor does he do twice as much managerial work. If this assumption about our samples is right, the sum of the coefficients in the "auxiliary" equation will add up to less than one and we shall consistently underestimate returns to scale.

Also, it is plausible to assume that firms with a higher level of entrepreneurial and managerial inputs may be less subject to capital rationing. That is, we may expect a positive correlation between managerial inputs and the level of capital inputs. If this is the case, the coefficient of capital inputs in the "auxiliary" regression of "management" on all inputs will be positive and we shall overestimate the elasticity of output with respect to capital inputs, and hence also overestimate the returns to capital.

I am aware of only one published attempt to include managerial services in the production function and it confirms my analysis. In a footnote to a recent paper, Earl R. Swanson reports on an attempt by F. G. Reiss at the University of Illinois to add an index of "managerial ability" or "quality" to the production function.[12] This addition riased the sum of the coefficients

[10] This association between the excluded and included variables should not be given a causal interpretation. The "auxiliary" regressions have no independent economic meaning. They are not "causal" or behavior equations, just summary devices. They help us to summarize the covariation of the excluded and included variables in our sample. Often in demand analysis, one can hear a statement like: "The intercorrelation between price and income is .95; hence my estimates of price and income elasticities are unreliable." The "auxiliary" regression of x_k on all the included variables has no more economic meaning than the regression of price on income implicit in the above statement. In fact, the whole argument of this note could be conducted in terms of partial correlation coefficients. The "auxiliary" regressions are just a simpler and easier way of saying the same thing.

[11] For example, see Earl O. Heady, "Production Functions From a Random Sample of Farms," *Journal of Farm Economics*, 1946, 28, 989–1004; Glenn L. Johnson, "Problems in Studying Resource Productivity and Size of Business Arising from Managerial Processes," Chapter 2 of *Resource Productivity, Returns to Scale, and Farm Size*, edited by E. O. Heady, G. L. Johnson, and L. S. Hardin, Iowa State College Press, Ames, 1956, 16–23; and G. Tintner, "A Note on the Derivation of Production Functions from Farm Records," *Econometrica*, 1944, 26–34.

[12] Footnote 10, page 137, of Earl R. Swanson, "Determining Optimum Size of Business from Production Functions," Chapter 15 in *Resource Productivity* . . . op. cit.

from .974 to 1.173, and reduced the coefficient of machinery and equipment from .146 to .138. These changes, however, were not statistically significant, which may be due to the inherent difficulty of defining and constructing such an index.

IV. *Disregarding Quality Differences*

Another kind of specification error occurs when we measure inputs without taking into account quality differentials. For example, we measure labor in terms of hours or months, as if one man's labor was the same as another's. It has been argued[13] that the neglect of "differences in the quality of people as productive agents" may substantially bias our analyses. With the help of our framework we may examine the impact of this omission.

Let q_iL_i be the "true" measurement of labor input, where L_i indicates the "quantity" measured in time units, and q_i is the multiplier associated with the i-th input of labor which transforms it into "equivalent effective labor units" and may be different for different people or on different farms. Instead of using q_iL_i in estimating the production function we use only L_i as our measure of labor. For simplicity let

$$Y = C^{a_c}(qL)^{a_1}e^u \tag{14}$$

be the true production function, while our estimate of it is

$$Y = C^{b_c}L^{b_1} \tag{15}$$

In the case of a Cobb-Douglas function it can be shown that the omission of q_i is equivalent to the leaving out of a variable q_i with the coefficient a_1. Then

$$Eb_c = a_c + p_c a_1 \tag{16}$$

and

$$Eb_1 = a_1 + p_1 a_1 = a_1 (1 + p_1) \tag{17}$$

and the p's are the least squares coefficients in the "auxiliary" equation

$$q_i = C_i^{p_c}L_i^{p_1} \tag{18}$$

I think that we can say the following about these p's. Higher quality labor will be usually associated with larger capital inputs, because it will increase the marginal productivity of capital and also because farmers in possession of "higher quality labor" may be less subject to capital rationing. Also, it is plausible that "quality is a substitute for quantity," and that holding capital constant, farms with higher quality labor will use less "labor" as it is conventionally measured. Hence it is plausible that $p_c > 0$ and

[13] T. W. Schultz, "Reflections on Agricultural Production, Output, and Supply," *Journal of Farm Economics*, August 1956, p. 757.

$p_1 < 0$, and that we shall overestimate returns to capital and underestimate returns to labor. This may explain why so often in studies of production functions we get unreasonably low returns to labor and very high returns to capital.

It is not clear what "returns to labor" are in this context. If quality varies at all, returns to quantity *and* quality are based on two a_1 not just one a_1. Hence we shall underestimate returns to "true" labor inputs unless quality varies one-to-one with quantity. If quality in fact varies inversely with quantity, we will even underestimate returns to labor as conventionally defined. If quality does not vary at all, there will be no bias in our estimate of returns to "quantity" alone.

The bias in our estimate of returns to scale will in this case equal

$$E(\hat{e} - e) = a_1(p_e + p_1 - 1). \tag{19}$$

Whether we assume $p_1 < 0$ or not, probably the quality of labor does not vary proportionally with the quantity of labor and capital inputs. It is doubtful that farmers with twice the capital or hours of labor as their neighbours enjoy twice the quality of labor. Hence we may expect $p_e + p_1 < 1$ and, therefore, we may also expect our estimates consistently to underestimate returns to scale.

The same analysis can also be applied to the problem of disregarding the quality of land and just using acres as a measure of inputs. Similarly it could be applied to the use of stocks instead of flows as our inputs, i.e. using total machinery rather than its services as an input. The impact of varying the rate of use or "depreciation" is analogous to the impact of quality differences. However, in each case we shall have to bring different knowledge to bear on the plausible signs and magnitudes of the various coefficients in the "auxiliary" regressions.

The particular examples used to illustrate the method are somewhat unfortunate as they raise the problem of the "correct" definition of returns to scale. Do we still want to use e as our definition of returns to scale if some of the "inputs" like management or quality are not under the farmer's control? They may have a price, but there is probably no perfect market in them. We may want to distinguish between "physical" returns to scale and returns to scale to "controllable" or "economic" inputs. The argument above applies to "physical" returns to scale. A similar argument can be presented with respect to bias in "economic" returns to scale. If we define it as the sum of the coefficients of the "controllable" variables and exclude the "noncontrollable" variables from estimation, the condition for no bias will be $\sum p_i = 0$. Hence we shall overestimate or underestimate "economic" returns to scale depending on whether the excluded "noncontrollable" variable is associated positively or negatively with the included variables. However, the bias in the estimates of individual coefficients will be as

strong as ever. No matter how we choose to define returns to scale, we cannot escape the consequences of not taking everything into account.

V. *The Omission of More Than One Variable*

The previous results generalize easily to the case where we leave out more than one variable from our analysis. If we leave out K relevant variables while including H, the expectation of our estimated coefficients will be given by[14]

$$E(b_i) = a_i + \sum_{k=H+1}^{H+K} p_{ik}a_k; \tag{20}$$

The bias in our estimate of returns to scale is given by

$$E(\hat{e} - e) = \sum_{k=H+1}^{H+K} a_k\left(\sum_{i=1}^{H} p_{ik} - 1\right) \tag{21}$$

The sign of the bias in our estimate of returns to scale will now depend not only on whether the excluded variables change more or less than proportionately with the included variables but also on the relative magnitudes of the coefficients attached to the variables that change more than proportionately as compared with the magnitude of the coefficients attached to the variables that change less than proportionately with the included variables.

VI. *Aggregation Over Inputs*

The literature on "perfect aggregation" is quite explicit on what we should do lest we get into trouble.[15] What we should do in the case of a Cobb-Douglas function—if we want to aggregate several inputs into one—is to use *geometric* indices with weights proportional to the elasticities of the respective inputs. Of course, if we knew the elasticities, we would not be trying to estimate them. Hence we are interested in what happens when we aggregate, but not as perfectly as we should; and then try to estimate the various coefficients of the production function. The answer to this problem follows from the framework outlined above and has been presented at length in Theil's recent book[16] and will be reproduced only briefly here.

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[14] We have as many nontrivial "auxiliary" regressions as there are left-out variables, and $P=[I\ p_{H+1} \ldots p_{H+K}]$.

[15] See for example, R. M. Solow, "The Production Function and the Theory of Capital," Review of Economic Studies, 23(2), No. 61, 1955–56, 101–108; R. W. Shephard, *Cost and Production Functions*, Princeton, 1953, particularly 61–71; and H. Theil, *Linear Aggregation . . .*, op. cit., Chapter 7. For other discussions of the aggregation problem, see also Nataf, A, "Sur la possibilité de construction de certains macromodels," *Econometrica*, Vol. 16 (1948), 232–244, and the contributions of L. R. Klein, K. May, and Shou Shan Pu in the October 1946 issue of *Econometrica*.

[16] Theil, *Linear Aggregation . . .*, op cit.

Theil does not deal with the Cobb-Douglas function explicitly, but it is simple to apply his conclusions to the problems under consideration.

Even though we cannot aggregate perfectly, we should try to go as far as we can in that direction. In particular, if we believe that the underlying production function is of the form of the Cobb-Douglas function, we should, in order to minimize bias, use geometric sums (i.e. products) rather than arithmetic sums in aggregating our inputs.[17] If we do so, it is possible to use our framework to explore the consequences of such aggregation.

Let all the variables be expressed in terms of their logarithms and let the true equation be

$$y = \sum_i a_{1i}x_{1i} + \sum_j a_{2j}x_{2j} + u \tag{22}$$

We are considering a simple case of aggregation over inputs where the inputs are divided into two groups (e.g. labor and capital) and aggregated geometrically. That is, we are going to use least squares to estimate

$$y = b_1x_1 + b_2x_2 \tag{23}$$

where

$$x_1 = \sum_i x_{1i} \quad \text{and} \quad x_2 = \sum_j x_{2j}.$$

Note that both x_1 and x_2 are sums of logarithms and not logarithms of sums.

The expectation of the estimated coefficients is given by[18]

$$E(b_1) = \sum_i p_{i1}a_{1i} + \sum_j p_{j1}a_{2j} \tag{24}$$

$$E(b_2) = \sum_j p_{j2}a_{2j} + \sum_i p_{i2}a_{1i}$$

where the p's are coefficients in the "auxiliary" regression of each of the x_{1i}'s and x_{2j}'s on x_1 and x_2. It can also be shown[19] that

$$\sum_i p_{i1} = \sum_j p_{j2} = 1 \tag{25}$$

and

$$\sum_i p_{i2} = \sum_j p_{j1} = 0 \tag{26}$$

Each of the estimates consists of a weighted average of the elasticities of the corresponding microvariables (the coefficients of the variables of which

[17] This is not strictly true. Using arithmetic aggregates could induce a bias in the opposite direction of the "aggregation" bias and hence reduce the total bias. However, there is no reason to expect it to do so.

[18] This is just a partition of and scalar notation for Eb=Pa.

[19] Theil, *Linear Aggregation* . . . op. cit., Theorem 1, p. 15.

the corresponding macrovariable is an aggregate) with the weights adding up to one, and a weighted sum of all the other elasticities in the "true" microequation, with the weights adding up to zero. For example

$$Eb_1 = \sum_i p_{i1}a_{1i} + \sum_j p_{j1}a_{2j}; \qquad \sum_i p_{i1} = 1 \text{ and } \sum_j p_{j1} = 0$$

Alternatively, the resulting estimate may be viewed as a weighted average of the corresponding microparameters plus a covariance correction involving the other, noncorresponding microparameters. These weights are again coefficients in the "auxiliary" regressions of each microvariable on all the aggregates.

No bias will arise if there is no association between the coefficients of the variables to be aggregated and these "weights." A sufficient condition for this to happen is that the level of various inputs should be independent of the magnitude of the elasticities. This is not too plausible in the case of production functions. Also, if there is a strong association among items in different aggregates, the covariance correction may become large and may also become negative, causing us to estimate a negative elasticity. Hence a "wrong sign" may not be a contradiction of our theory but just an indication that we are having aggregation trouble. In particular, this is liable to happen to variables whose contribution is relatively small. The weighted-average term is then small and the covariance correction may predominate.

The bias in the estimate of returns to scale is given by

$$(27) \quad E(\hat{e} - e) = \sum_i a_{1i}(p_{i1} + p_{i2} - 1) + \sum_j a_{2j}\, p_{j1} + p_{j2} - 1)$$

This is analogous to the case of several left-out variables except that we have additional restrictions on the sums of the p's. There will be no bias in the estimate of returns to scale (1) if the individual elasticities are the same within each aggregate [$a_{1i} = a_1$ and $a_{2j} = a_2$ for all i and j], or (2) if there is no systematic association between the individual elasticities and the coefficients in the "auxiliary" regressions

$$\sum_i a_i p_i \approx \sum_i a_i \sum_i p_i \ ,$$

or finally (3) if we have "constant returns to scale" in the "auxiliary" regressions on the average. The weighted average of these "returns" should be one, the weights being the corresponding microelasticities. This would happen if proportional changes in all the aggregates were on the average associated in our sample with changes in the same proportion in all the microvariables.

All this holds only if we at least attempt to aggregate correctly, i.e. geometrically and not arithmetically. If we do not do so, the restrictions

on the sums of these weights do not hold any more and the problem becomes too difficult to handle. However, in a particularly trivial case hardly any trouble arises. If the inputs to be aggregated into one variable are used in fixed proportions, or nearly so, aggregation will cause no trouble. Even if we use their sum, rather than their product as we should, this will affect only our estimate of the constant term and will not bias our estimates of the individual elasticities or of the returns to scale. However, inputs in one group should not be associated in fixed proportions with inputs in another group, as this will cause us covariance trouble.

VII. *Some Limitations*

It may be noted that I have omitted constant terms throughout. This was done for the sake of simplicity, and because the constant term rarely has an interesting economic meaning. However, the method applies as well to the constant term. The expectation of the constant term will be a weighted sum of all the parameters in the true specification with the weights being the constant terms in the "auxiliary" regressions.

We did not consider the case when there is also a specification error in the dependent variable y. This, however, is not a serious omission, as at least some "errors" in the dependent variable y can be transferred to the right side of the equation and considered as "errors" in the independent variables.

More serious is the restriction to linear equations, or at least to equations linear in the parameters. However, we rarely use other functions in empirical work, as their statistical estimation becomes very difficult.

The restriction that X and $\overline{X}$ be non-stochastic precludes us from considering random errors of measurement. Nevertheless, if we admit some approximations,[20] it is even possible to do this.

Although we dealt only with estimates based on least squares, the method can be extended to any *unbiased* method of estimation, and even further. In particular, we can easily take into account weighted regression. We did not deal, though, with problems due to the simultaneity of various economic relationships. The best reference here is still Marschak and Andrews.[21] Nor did we take up the question of "intrafirm" versus "interfirm" production functions. The literature on this point, although quite slim, is ample.[22]

[20] See H. Theil, *Forecasts and Economic Policy* (forthcoming). Appendix to Chapter 6; and D. V. Lindley, "Regression Lines and Linear Functional Relationship," *Journal Royal Statistical Society*, Supplement 9 (1947), 218–44.

[21] J. Marschak, and W. H. Andrews, "Random Simultaneous Equations and the Theory of Production," *Econometrica*, 12: 143–205, 1944.

[22] See M. W. Reder, "An Alternative Interpretation of Cobb-Douglas Production Functions." *Econometrica*, Vol. 11, No. 3; and M. Bronfenbrener, "Production Functions: Interfirm-Intrafirm," *Econometrica*, Vol. 12, No. 3.

The major restriction of our framework lies in the fact that we must assume that something is "true,"—we must specify our "true" equation. In practice, we may have very little to go on. However, our work will have no statistical validity unless we are ready to stick our necks out and to assume that something is "true."

VIII. *Conclusion*

We have explored the impact of some common "compromises" on the resulting estimates of the Cobb-Douglas production function. The method outlined above may help us to interpret our results if—and this is a big if—we can say something about the behavior of the "true" variables. It is important, however, to be consistent and to use this type of analysis not only when we want to rationalize "bad" results but also to cast doubt on "good" results.

THE MARKET AS A UNIT OF INQUIRY IN AGRICULTURAL ECONOMICS RESEARCH*

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I

EVERYONE living in the commercial world has a general notion of what constitutes a market; it is a place, or sphere, where buying and selling occurs. And this general notion seems to satisfy the definitional requirements of descriptive studies concerned with the physical facilities, product characteristics and institutional practices of markets. But this general notion is inadequate from the viewpoint of economics; it fails to take into account the roles played by the market forces of supply and demand. Hence, the above concept of a market is of little use to the economist concerned with price formation and market behavior.

Economic analysts do not, however, want for definitions of a market. Following in the tradition of Cournot, Marshall defined a "perfect market" as follows:[1]

". . . a district, small or large, in which there are many buyers and many sellers all so keenly on the alert and so well acquainted with one another's affairs that the price of a commodity is always practically the same for the whole of the district."

In its modern form, the Marshallian formulation is given in the 1933 edition of the Encyclopedia of the Social Sciences as follows:[2] "A market . . . is the area within which the forces of supply of demand converge to establish a single price." With the emergence of imperfect, or monopolistic, competition theory, however, the idea of a single price for a given area encountered rough going. In fact, it became invalid insofar as imperfect competition theory provided representative explanations of market behavior. Thus, in recent years definitions of a market have emphasized, as the key idea, *forces at work* rather than the singleness of price or physical area.

The concept of a market at the present stage of economic thinking may then be stated as follows: a market is *some* sphere, or space, where

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[1] *Principles of Economics,* Macmillan and Co., London, 8th ed., p. 112.

[2] Volume IV, page 131.

(a) the forces of demand and supply are at work, (b) to determine, or modify, price, (c) as the ownership of some quantity of a good, or service, is transferred, and (d) certain physical and institutional arrangements may be in evidence.

But this general and abstract concept of a market is not helpful in developing answers to the question commonly asked—namely, *what type of behavior dominates markets in agriculture?* It is of little, or no, help in delimiting markets in practice, or in providing guide lines for investigating the behavior of markets. And some recent experiences with a cooperative research project at the University of Minnesota,[3] which sought answers to the question—what type of behavior dominates certain markets in Minnesota—suggest that answers to this question must wait until reasonably satisfactory solutions are found to two procedural questions: First, how does the researcher define the boundaries of a market in an empirical study? Second, what constitutes the economic structure of a market? Or what are the structural elements of a market? And then, how do you select them and what do they do? The remainder of this paper will be devoted to a discussion of these procedural, or methodological, questions.

II

Anyone who has tried to set the boundaries of a market in objective terms must have felt the terrible vagueness, or emptiness, that closes in on one, once the problem is confronted seriously. The physical facilities of the marketplace have no meaning in terms of the boundary limits of the forces of supply and demand. The idea of a crop, or commodity, producing shed—the area of product concentration in marketing—is seductive. But is such an area coterminous with the forces of demand and supply in the unknown market to be defined? And the economic concept of *a unique and sharp break in the chain of substitution among commodities* has not, and probably cannot, be made operational.[4]

Papandreou feels that this impasse, which the researcher encounters in the first stages of an economic analysis of a market, can be turned.[5] He

[3] This project, now terminated, was cooperative between the Agricultural Marketing Service and the Minnesota Agricultural Experiment Station. It is an open secret that the research results of this project have been scarce and disappointing. At least a part of the explanation for this lack of success rests in the conceptual quagmire that we loosely call a market. Hence, this paper is intended to help chart an empirical research route through this conceptual quagmire.

[4] The idea advanced by Joan Robinson in her *Economics of Imperfect Competition*, Macmillan and Co., 1938, p. 17.

[5] The arguments in this section, which are largely attributed to Papandreou, grow in large measure out of conversations with him and his students. They may be found in the recent volume by A. G. Papandreau and J. T. Wheeler, entitled *Competition and Its Regulation*, Prentice-Hall, Inc., 1954, Chapters 2 and 4.

argues that the boundaries of a market may be delimited, if the buyers and sellers who are affected by common forces of supply and demand can be identified. And they can be identified, he argues further, with the aid of a *cross-demand schedule,* or curve.

The cross-demand schedule states a relation between the quantity demanded of the product of *one firm* and the price of the product of *a second firm,* assuming that tastes, incomes and other product prices hold constant. In other words, the cross-demand schedule describes the quantity demanded of product Y produced by firm A as the price of product X produced by firm B varies, and the price of Y and all other influencing factors hold constant. Now, where the quantity of product Y demanded, increases as the price of product X increases, it must be the case that Y is substituted for X (i.e., the products are substitutes). Thus, the firms producing products X and Y are subject to the common market force of demand, hence are in competition with one another, and, according to Papandreou, belong to the same market group.[6]

But where the quantity demanded of some product R does not change as the price of a second product S varies, the two products may be said to be unrelated. The quantity of R demanded is not influenced by a change in the price of S. Thus, the firms producing products R and S are not subject to the common market force of demand and the firms fall into separate market groups. These ideas are portrayed graphically in figure 1.

Papandreou deduces a general rule from these and other cases.[7] Two products are substitutes for one another, and the firms producing the two products involved fall in the same market group whenever the cross-demand curve for their products is generally increasing (i.e., positively inclined). With several important refinements left unmentioned and a comparable body of reasoning with respect to the cross-supply curve for buying firms, this then is the analytical device that Papandreou provides for delimiting the boundaries of a market.

It becomes clear upon using the analytical device of the cross-demand (or cross-supply) curve to indentify firms falling into common market groups, even at a conceptual, or hypothesizing, level, that markets typically do not exist in isolation. Markets commonly and typically overlap –that is, a firm, or group of firms, in one market may also be a part of a second market or even several markets. This will be the case where the product of a selling firm is a substitute for the product of a second firm

[6] Persons familiar with market structure theory will recognize the dependence of these ideas on the earlier work of Robert Triffin with the theory of external interdependence. See Triffin's *Monopolistic Competition and General Equilibrium Theory,* Harvard University Press, 1940, Chapter III.

[7] The interesting, but really irrelevant, case of *complementarity* is omitted here to economize time and space.

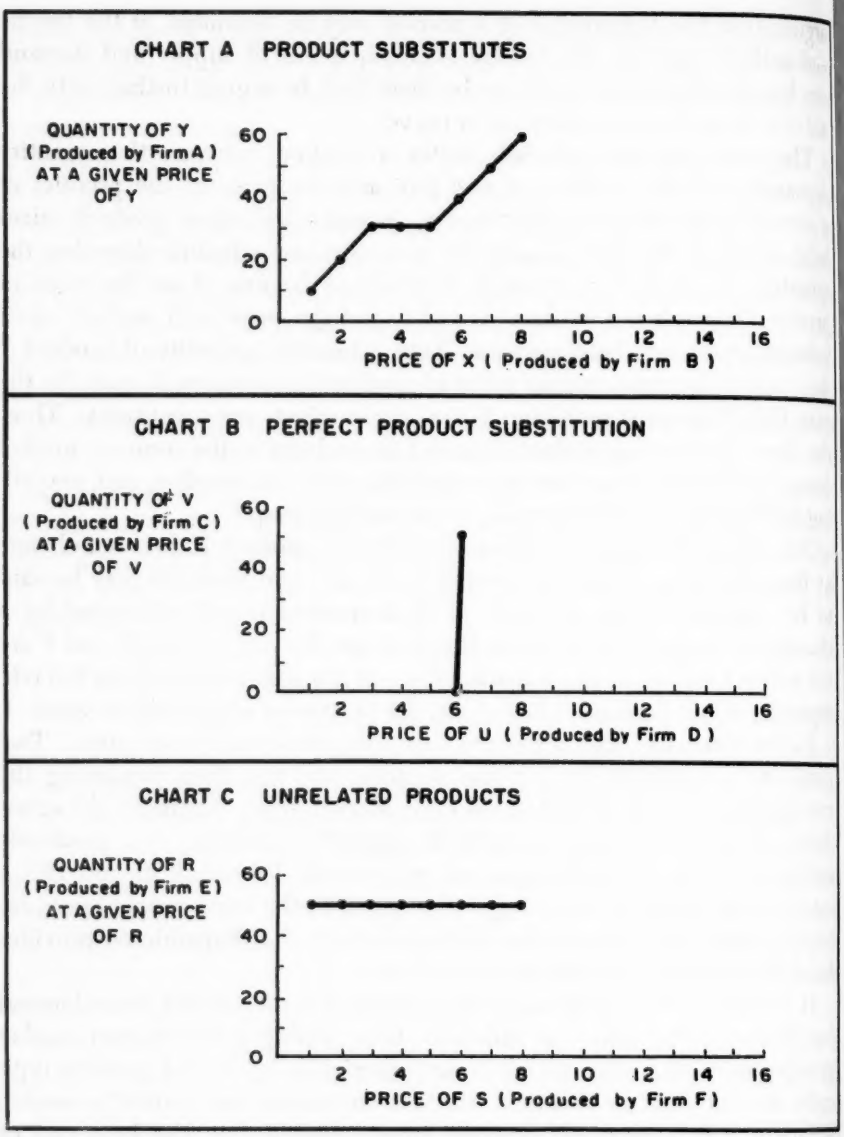
CHART A PRODUCT SUBSTITUTES
QUANTITY OF Y (Produced by Firm A) AT A GIVEN PRICE OF Y
60
40
20
0
2 4 6 8 10 12 14 16
PRICE OF X (Produced by Firm B)
CHART B PERFECT PRODUCT SUBSTITUTION
QUANTITY OF V (Produced by Firm C) AT A GIVEN PRICE OF V
60
40
20
0
2 4 6 8 10 12 14 16
PRICE OF U (Produced by Firm D)
CHART C UNRELATED PRODUCTS
QUANTITY OF R (Produced by Firm E) AT A GIVEN PRICE OF R
60
40
20
0
2 4 6 8 10 12 14 16
PRICE OF S (Produced by Firm F)

FIG. 1. CROSS-DEMAND CURVES BETWEEN PAIRS OF SELLING FIRMS: THREE SITUATIONS

and a third firm (i.e., positively inclined cross-demand curves run between the first firm and the second, and the first firm and the third), but the products of the second and third firms are unrelated (i.e., the cross-demand curve between these firms is horizontal). This phenomenon is illustrated in Figure 2. In chart A, firms A, B and C fall in a common

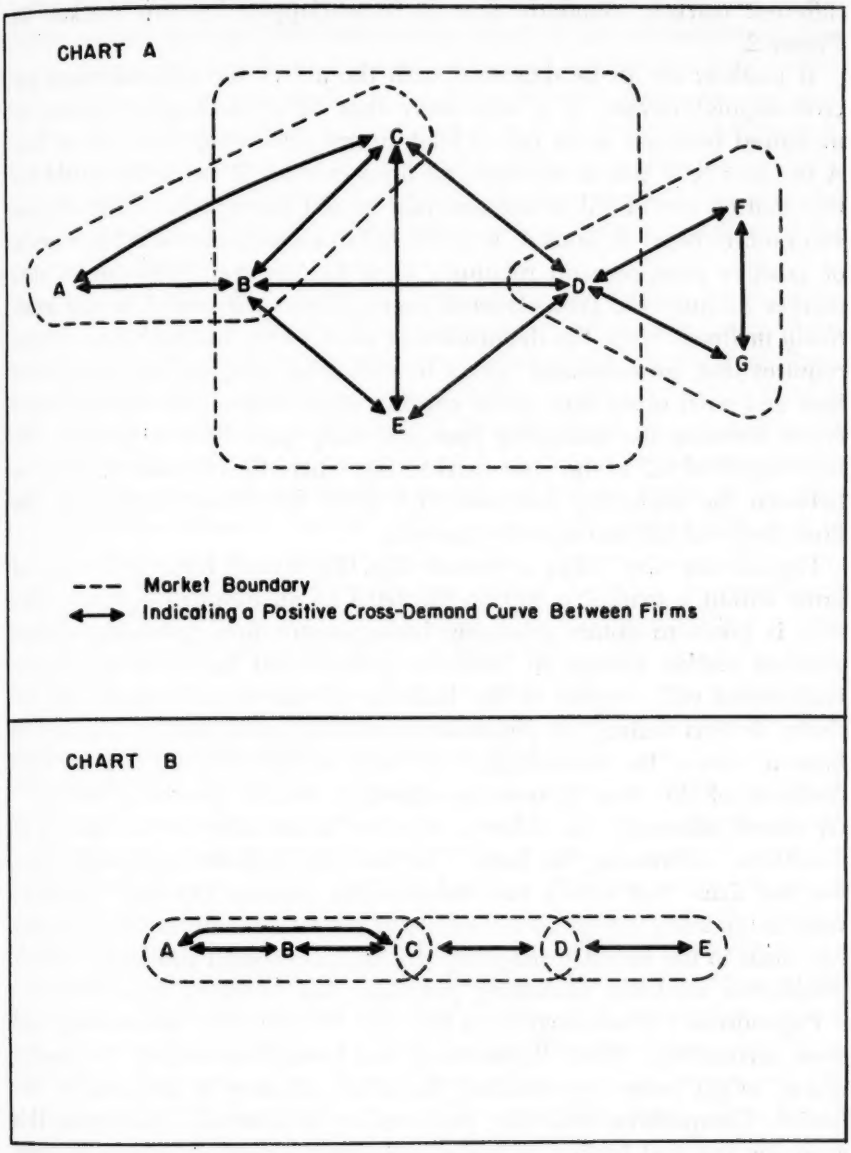

FIG. 2. MARKET GROUPS: TWO ILLUSTRATIVE SITUATIONS

market group, because the cross-demand curve between each of these firms is positive. And firms B, C, D and E fall in a common market group, because the cross-demand curve between each of these firms is positive. As a result we have market overlapping—firms C and B are a part of two

different markets. Similarly firm D is overlapped by two markets in Figure 2.

If markets are to be delimited with the aid of the cross-demand (or cross-supply) device, it is imperative that all cross-demand curves be measured between or be linked back to one *anchoring firm*, say to firm A in chart B. If this is not done, all firms in chart B, or in the world for that matter, would fall in one common market through the chain of substitution. In chart B, firms A, B and C fall in a common market by reason of positive cross-demand relations. Firm D, however, falls out of that market *because the cross-demand curve between it and A is not positively inclined*. Thus, the delineation of markets by this analytical device requires that cross-demand curves be estimated between one designated firm and each other firm under consideration. Where the cross-demand curve between the anchoring firm and each other firm is positive, the firms involved fall in the same market. But where the cross-demand curve between the anchoring firm and each other firm is non-increasing, the firms involved fall into separate markets.

Papandreou now takes a second step. He would form *subgroups* of firms within a market group on the basis of an industry concept. This step is taken to obtain relatively homogeneous firm groupings—homogeneous market groups—to facilitate analysis and the drawing of generalizations with respect to the behavior of the firms involved. An industry is thus defined by Papandreou as being composed of a group of firms in which "the technological decision, market decision, organization decisions of the firms in question display a *similar structural pattern*."[8] Or stated differently, an industry requires "a similarity in the *totality* of conditions confronting the firms."[9] Within each industry subgroup, then, we find firms that satisfy two independent criteria: (1) Any two firms with the industry subgroup are sellers of substitute commodities. (2) Any two firms in the industry subgroup display an essential similarity in their production methods, marketing practices and business organization.

Papandreou's terminology is, in the view of this writer, unfortunate and even misleading. What Papandreou has termed a market, or market group, might more appropriately be called an *area of competitive behavior*. Competitive behavior, personal or impersonal, dominates this grouping but that feeling of "acceptance by the group because we have and share common experiences" that come with the more homogeneous industry subgroups, and which in the commercial world is considered an attribute of a market, may, or may not, be present in the Papandreou formulation of a market. Hence the term, market, or market group, might

[8] *Op. cit.*, p. 59.
[9] *Op. cit.*, p. 60.

better be reserved for the situation described by Papandreou as an industry subgroup. And this shall be our usage in the remainder of this paper. *Firms are members of the same area of competitive behavior if they satisfy one criterion: the cross-demand curve between any pair of firms is positively inclined. Firms are members of the same market if they satisfy two criteria: fall in the same industry as well as in the same area of competitive behavior.* And finally the term marketplace shall be used to describe a set of physical facilities and institutional arrangements within a market.

Several critical implications of these Papandreou ideas need to be spelled out at this point. In the first place, the boundary limits of an area of competitive behavior constructed from some aggregation of firms, each of which is in competition with at least one other firm, can, or will, vary will the anchoring firm selected for measuring the cross-demand curves. For example, each firm in Chart B of Figure 2 is in competition with at least one other firm in that aggregate, but the limits of the area of competitive behavior derived will depend upon whether firm A or C or D or E is selected as the anchoring point of investigation. This arbitrary aspect of boundary determination should, however, be minimized at the market level; as *any* firm selected as an anchoring point within an industry should, it would seem, yield a market with about the same boundaries as that of any other firm selected. There is one possible exception, namely, where the industry grouping tends to be broader than the area of competitive behavior (e.g., in fluid milk).

In the second place, the reasoning to this point has been developed in terms of the selling side of the market—for the selling group. It has been assumed that transactions across the market serve to identify the buying firms, hence delimit the total market. And transactions do serve this purpose. But it does not follow that the boundary limits of a market will be the same, whether the identification process begins on the selling side or the buying side. A group of relatively homogeneous firms on the selling side might be entering into transactions with buying firms falling into two or more industries, and had the identification process begun on the buying side, only those buying firms in one industry would fall into a common market along with the relevant supplying firms. Thus, and in the third place, a market is not an objective thing like a building, that turns out to be the same shape regardless of the point of departure of the investigation. The market area to some degree, and the area of competitive behavior to an important degree, turn out to be relative things whose limits depend upon the focus of the inquiry.

By this time another question should be troubling many—if not most—readers. That question is—can the general approach outlined above be

made operational? Can it be used in practice to delimit markets? And the answer must be no, if by *use* we have in mind a direct, quantitative procedure. It can't for two reasons. First, the necessary price-quantity data do not exist. Second, even if the data limitation were not involved, the delineation of markets by estimating cross-demand curves between all firms that might be involved would be prohibitive in terms of time and money costs.

Has the writer, thus, built a straw man, as one critic has suggested? Or has he helped chart a course for guiding empirical inquiries in this area of markets? Only time will tell, but it would be a mistake to conclude that nothing has been gained because data cannot be substituted directly into cross-demand (or cross-supply) curves. We have something here akin to the demand estimation problem. We cannot derive estimates of consumer demand from consumer utility functions or indifference maps; but the theory of consumer behavior is invaluable in guiding statistical estimating efforts in demand studies. The theory of consumer behavior guides the investigator in the choice of variables, the construction of economic models, and the selection of statistical estimating procedures.

Papandreou's market theory may be used in a comparable way to guide empirical researches of markets. First, and foremost, it puts the market identification problem (or boundary problem) in a form amenable to solution, namely, in terms of the decision-making firms comprising the market. For a market bounds firms, not space, or air, or something else. A market bounds firms that (1) are confronted with a similar totality of conditions and (2) whose decisions give rise to common forces of demand and supply. Second, the Papandreou market theory classifies the kinds of external relations existing among firms, and makes clear the meaning of these relations for market delineation. Third, it suggests the elements, or characteristics, that should be considered in defining the limits of a market, or an area of competative behavior, and the kinds of data that should be collected to give those characteristics empirical content.

In sum, it is the contention of this writer that, if the analyst understands the Papandreou approach, *and at the same time has an intimate knowledge of the performance of and the conditions confronting some aggregation of firms,* he can make some useful approximations of the boundary limits of areas of competitive behavior and markets for the firms involved. The establishment of market boundaries in this way is based on information and evidence, but the precise demarcations are a matter of personal judgment. This informal procedure, thus, does not yield the precision that the careful researcher seeks. But it does yield working hypotheses regarding the limits of a market, hence enables the

researcher to proceed with an analysis of the performance of firms in the market.

III

The term "market structure" is often used in discussions of types of markets, or in the classification of markets, but it is rarely defined.[10] Common usage of the term does, however, suggest its intended meaning. By structural element most writers seem to have in mind some characteristic, or consideration, or condition, in a market which influences the behavior of firms in the market, hence the performance of the market. That is, they have in mind some characteristic, or consideration, or condition, in a market which influences one, or the other, or both, of the market forces of demand and supply. Hence, markets are commonly classified according to their structure—the performance of markets being deduced from their structure in the simpler classifications,[11] and it being assumed that markets vary in their performance as their structural characteristics vary in the more complex classifications.

This does not mean, however, that everything, or anything, that influences the decision making of sellers and buyers in a market may be termed a structural characteristic. Factors affecting the decision making of marketers may be thought of as falling into three different categories: (1) those external to the market (e.g., national income, war), (2) those internal to individuals operating in the market (e.g., the state of a buyer's ulcers, or the whimsey of a seller's wife), and (3) those *peculiar* to and *significantly* influential in the market itself. The number of buyers, or sellers, in a market immediately comes to mind as a characteristic that satisfies both conditions of category 3. On the other hand, the room temperature on the trading floor of a market place probably does not significantly influence the behavior of marketers, hence is not a factor under category 3. And, of course, by the term market structure, we have in mind the set of factors, or characteristics, that fit category 3 above.

It seems desirable to digress briefly at this point to discuss the role played by production functions (and the relations into which they may be converted, namely, cost functions) and the utility functions of consumers in the market. Should these production and utility functions be classed as structural characteristics of the market, or should they not?

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[10] This writer knows of only one concise definition of market structure. Professor E. S. Mason in his article "Price and Production Policies of Large-Scale Enterprise," *The American Economic Review*, Part 2, Supplement, March, 1939, gives this definition: "The structure of a seller's market, then, includes all of those considerations which he takes into account in determining his business policies."

[11] See, for example, R. L. Bishop, Elasticities, Cross-Elasticities and Market Relationships, *American Economic Review*, Dec., 1952, and Fritz Machlup, *The Economics of Sellers Competition*, Johns Hopkins Press, 1952, particularly Chapter 4.

Technically each exerts an influence on the position and configuration of the relevant relation, demand or supply. Thus it may be argued that production functions and utility functions should be viewed as structural elements of a market. But, in fact, they are rarely, if ever, assigned this role in economic theory. They are not, it would seem, because conceptually they differ in degree, and to an important degree, from market structural elements. Production functions and utility functions influence the position and configuration of market supply and demand functions respectively, because the latter relations *are* with certain conversions the former relations. Marginal cost relations summate into market supply relations and marginal utility functions, converted into money units, summate into market demand relations. Thus, we don't classify production functions and utility functions as structural characteristics of the market. They *are* the supply and demand relations of the market which we say *structure* influences (i.e., the market forces on which a structural characteristic of the market exerts an influence).

When asked to give an example of a structural characteristic of a market, an economist will invariably name two, and possibly in the following order:

(1) Number of operators in the market, and
(2) Product homogeneity (or with somewhat different emphasis, product differentiation).

This may seem strange to the uninitiated, but in this case the intuition of economists has led them straight. The form taken by these two market structural characteristics determines in large measure the "power relations" in the markets involved—determines who does what to whom and how much. Hence, an analysis of markets in terms of these two characteristics leads directly to the heart of the market performance problem.

A large number of sellers in a market leads to atomistic power relations in that market wherein a single seller cannot influence the price of the product, hence cannot affect the sales of a competitor (a large number of buyers, of course, leads to a corresponding situation). A few sellers in a market leads to some combination of circular power relations (depending on the exact number of firms, and the extent to which one, or more, dominate), where one seller can reduce the price of his product and hence can affect the sales of a competitor. Product homogeneity, or more precisely the degree of product homogeneity, in a market influences the form and intensity of competition among the firms comprising that market. Perfect, or near perfect, product homogeneity in markets characterized by circular power relations leads to intense rivalries, hence often to some form of collusion to moderate that rivalry. Heterogeneous, or differentiated, products in a market, on the other hand, generally result

in a less intense form of competition, namely, product competition.

It should be recalled at this point that a market is defined not only in terms of positive substitutional relationships, but also in terms of an industry concept. Thus, it seems reasonable that some of the common characteristics of an industry should in fact constitute structural characteristics of the market bounding that industry. That is, some or all of those things that give firms an essential similarity, hence throw them in the same industry and market should influence the behavior of the market and the firms comprising it. And this influence, whatever it may be, will be registered in terms of a change in the position, or configuration, of the demand and/or supply relations, *for it is only by influencing one or the other of these forces that market behavior can be affected.*

Jerry Law, in his study of market structures in agriculture,[12] suggests that five market characteristics arising out of the industry concept be viewed as structural elements of agricultural markets. They are:

(1) Durability of the product.
(2) Adequacy of grade description for buying and selling.
(3) Bulkiness of product in relation to its value.
(4) Ratio of overhead costs to variable costs.
(5) Continuity and length of the production process.

This list of industry oriented structural elements was refined from two principal sources of ideas and information: (1) the discussions of Joe S. Bain,[13] J. M. Clark,[14] Edward S. Mason,[15] and Fritz Machlup,[16] with respect to market characteristics having an important influence on the behavior of the markets and (2) the vast literature in the field of agricultural economics describing agricultural "markets."

We can comment on each of the above characteristics only briefly. Durability of the product has a bearing on the ease of storeability, hence influences the elasticity of supply. Adequacy of grade description influences knowledge in the market, hence the sharpness of the forces of supply and demand, hence in turn upon the ease of price discovery. Bulkiness of product in relation to its value has an influence on the area over which it may be substituted for other products, hence upon market numbers, hence in turn upon the slope of the demand curve confronting

[12] As a part of the cooperative project between the Agricultural Marketing Service and the Minnesota Agricultural Experiment Station.

[13] "Market Classifications in Modern Price Theory," *Quarterly Journal of Economics*, August, 1942, pp. 560-574.

[14] "Toward a Concept of Workable Competition," *American Economic Review*, Part I, June, 1940, pp. 241-256.

[15] "Price and Production Policies of Large-Scale Enterprise," *American Economic Review*, Part 2, Supplement, March, 1939, pp. 61-74.

[16] "Monopoly and Competition: A Classification," *American Economic Review*, September, 1937, pp. 445-451.

producers. Ratio of overhead costs to variable costs has a direct effect on the supply response of producers, hence upon the slope and position of the market supply relation. Continuity and length of production also has a direct influence on the slope and position of the supply relation.

Perhaps other characteristics of agricultural markets should be added to the above list of structural elements.[17] But including numbers in the market and product homogeneity, we now have seven structural elements. And if we are interested in developing a classification of markets in agriculture by structure, even seven elements yield an unwieldy scheme. Depending upon the number of break-downs per structural element, the number of cells in the classification (i.e., classes of markets in agriculture), with seven elements might run as high as 1,500. That is a lot of classes of markets. Perhaps there are really this many classes of markets in agriculture; perhaps there are even more. But a system of classification with 1,500 cells comes dangerously close to defeating the purpose of classification—namely, the organization of phenomena into orderly groupings such that the mind can grasp the meaning and significance of the ordering.

In any event, employing the structural elements presented above, each of which *a priori* appears to exert a significant influence on the behavior of firms within markets, hence upon price-quantity determinations, a classification of markets in agriculture emerges as follows:

I. Many buyers—many sellers.[18]
  A. Product relatively homogeneous.
    1. Product highly perishable.
      a. Product can be sold on grade description.
        (1) Product bulky in relation to value.
          (a) Overhead costs of producers higher than variable costs.
            (i) Production process continuous and over a year in duration.
            (ii) Production process continuous and less than a year in duration.
            (iii) Production process discontinuous and over a year in duration.

[17] One is tempted to add the structural element, ease of entry, which certainly is a key factor in market behavior. But it can be argued that this structural element has a direct influence on numbers in the market, hence may be omitted in this classification since numbers in the market are included.

[18] This classification takes into consideration both sides of the market, since in any analysis of the performance of a market, the policies and actions of buying firms are just as important as those of sellers. This, of course, is true even though the identification process begins on the selling side as it most often does in studies of agricultural "markets."

(iv) Production process discontinuous and less than a year in duration.

(b) Overhead costs of producers less than variable costs.

(Repeat all headings under (a) directly above.)

(2) Product not bulky in relation to value.

(Repeat all headings under (1) directly above.)

b. Product cannot be sold on grade description.

(Repeat all headings as under a. above.)

2. Product relatively durable.

(Repeat all headings under 1. above.)

B. Product heterogeneous.

(Repeat all headings under A. above.)

II. Few buyers with a dominant firm—many sellers.

(Repeat all headings under I. above, and for the following Roman numerals.)

III. Few buyers, none dominant—many sellers.

IV. Few buyers with a dominant firm—few sellers with a dominant firm.

V. Few buyers, none dominant—few sellers with a dominant firm.

VI. Few buyers with a dominant firm—few sellers, none dominant.

VII. Few buyers with a dominant firm—few sellers, none dominant.

VIII. Many buyers—few sellers, none dominant.

IX. Many buyers—few sellers with a dominant firm.

X. Single buyer—many sellers.

XI. Single buyer—single seller.

XII. Many buyers—single seller.

Given this classification of agricultural markets as a hypothesis of the structure of markets in agriculture, the tasks of empirical research in this general area may be suggested. These tasks appear to be of two principal types:

(1) The testing of, and refining of, the above classification as a description of markets in agriculture,

(a) By adding structural elements which have a significant influence, and deleting those that do not, and

(b) By washing out those cells in the classification which have no real world counterparts.

(2) The development of a description of the behavior of markets falling in each of the remaining cells

(a) By setting forth a hypothesis regarding the behavior of markets falling in each cell, and

(b) By investigating particular aggregations of firms engaged in buying and selling

(i) To define the limits of the markets involved, and
(ii) To observe and measure the behavior of firms in the delimited markets.

This is no small order; it is, in fact, a boundless and never ending job. Hence, it cannot be done in a complete fashion, and probably will not be done in a thorough fashion, in the years immediately ahead. But a reorientation of some of our marketing work in the direction of studying the market forces of demand and supply *at work in differently structured "markets"* would still many an argument concerning the performance of markets in agriculture.

IV

In thinking about price formation and market behavior in agriculture, we are sometimes impressed by the over-all tendency for agriculture to approach that market condition traditionally described as pure competition, where the power relations are atomistic. And we are sometimes impressed by the apparent circular power relations existing among few buyers, or sellers, in particular marketplaces. Is agriculture, then, to be characterized as a sector of the economy composed primarily of similarly structured markets involving (1) atomistic power relations and (2) homogeneous products? Or is it to be characterized by markets of widely varying structures as suggested by the tentative classifications of markets in section III? In an effort to use the foregoing ideas and to relate those ideas more directly to agriculture, we shall in this section advance a general hypothesis regarding the behavior and performance of markets in agriculture.

The general hypothesis that we have in mind is not startling, but it does have important implications. It is that farm product markets (i.e., prior to processing stages) are typically *atomistic* in their power relation with the result that rivalry is impersonal, prices administered by private parties are uncommon and profits tend to be competitive. There are exceptions; fluid milk markets come immediately to mind, but they appear to be exceptions.

Areas of competitive behavior in agriculture are wide for several reasons. First, because product homogeneity is a common attribute of agricultural products. Second, because many, small producers are engaged in producing each of these relatively homogeneous products. And third, because close substitutional relations exist among many of these relatively homogeneous products for producers and consumers alike. Further, there would appear to be a great deal of overlapping among these areas of competitive behavior.

Thus the general picture that emerges is one of a network of over-

lapping areas of competitive behavior within agriculture; but much less overlapping as between agriculture and nonagriculture. Product substitutability weakens between farm and nonfarm products. Hence, we get something approaching a self-contained sea of competitive behavior for agriculture as a whole.

A market, it will be recalled, is delimited by the boundaries of an industry, and must be located entirely within *one* area of competitive behavior. The first condition results in an essential similarity of firms, the second in a positively inclined cross-demand curve among all pairs of firms involved (a market may *also* fall partially or wholly into a second or third area of competitive behavior). Where markets are defined in this manner, *a homogeneous product* becomes a useful criterion for determining the limits of the industry, hence, the market. Firms producing a relatively homogeneous product are likely to have similar technological patterns in production as well as similar marketing practices. And although product homogeneity does not assure an essential similarity among producers with respect to business organization, some correlation may be presumed. Thus where empirical guides are lacking, the delineation of markets along commodity lines in agriculture would seem to be a logical approach. *The production of a homogeneous product forces an essential similarity among the firms involved.*

Granted this conclusion, we should expect to find agricultural markets commodity-wide in the United States, where commodities are relatively homogeneous, and where barriers to commodity substitution, institutional or physical, are known not to play an important role. Bearing in mind the above limiting conditions, markets would seem to be commodity-wide for the following commodities:

1. all hard wheats
2. hogs
3. beef cattle
4. corn
5. eggs
6. soybeans
7. cotton
8. potatoes.

Boldly stated, it is our hypothesis that all producers in the United States in each of the commodity categories listed above fall into one market—a market commodity-wide.

This hypothesis may be illustrated further from some work done by Arthur Domike on the structure and performance of wheat and barely markets.[19] His work suggests that all producers of wheat and feed grains

[19] As a part of the cooperative project between the Agricultural Marketing Service and the Minnesota Agricultural Experiment Station.

fall in one common area of competitive behavior and that all producers of hard wheats (winter and spring) fall in one market grouping. Thus the solid line in Figure 3 bounds all producers of wheat and feed grains and delineates an area of competitive behavior common to those producers. The dotted line bounds all producers of hard wheat, hence delineates the market for hard wheat. The overlapping of areas of competitive behavior is also illustrated in Figure 3; for example, some corn and other feed grain producers fall into two different areas of competitive behavior—one along with wheat producers (bounded by the solid line) and another along with processors and sellers of oil meals (bounded by the dashed line). Similarly, some producers of corn and other feed grains are overlapped by another set of competitive areas—one along with wheat producers (bounded by the solid line) and another along with localized groups of roughage producers (bounded by the chain of small noughts). The barley case is, however, more complex. Barley produced in the Upper Midwest is used both for livestock feeding and for malting. Thus, producers of barley in the Upper Midwest fall into two different areas of competitive behavior—one with feed grain and wheat producers and one with producers of malting barley throughout the United States (and possibly in world trade). And a market for barley produced in the Upper Midwest is postulated on the ground that the product has certain unique malting qualities.

The pattern of markets and of areas of competitive behavior, presented in Figure 3, emerges from an identification process, albeit a rough one, from the farmer-producer, selling side of the market. If the identification process had originated on the buying side—with the millers, merchandisers, feed mixers and manufacturers and maltsters—the graphic portrait in Figure 3 might look strikingly different.

The breadth, or inclusiveness, of the area of competitive behavior bounding producers of feed grains and all wheat results from the effective substitutional relationships involved. Any single producer of hard wheat who continued to lower his offering price would first draw buyers away from all other producers of hard wheat, then from producers of any wheat and ultimately from all producers of feed grains as wheat at very low prices was substituted for feed grains. *The fact that any one producer of hard wheat could not make deliveries to all buyers is irrelevant at this point.* The substitutional relations that exist among producers which would allow the single producer of hard spring wheat to draw buyers away from the other producers of wheat and feed grains, *if he could make the deliveries,* is what matters at this point—is what determines the area of competitive behavior in this case. And the similar technological aspects of the product hard wheat, as well as the similar

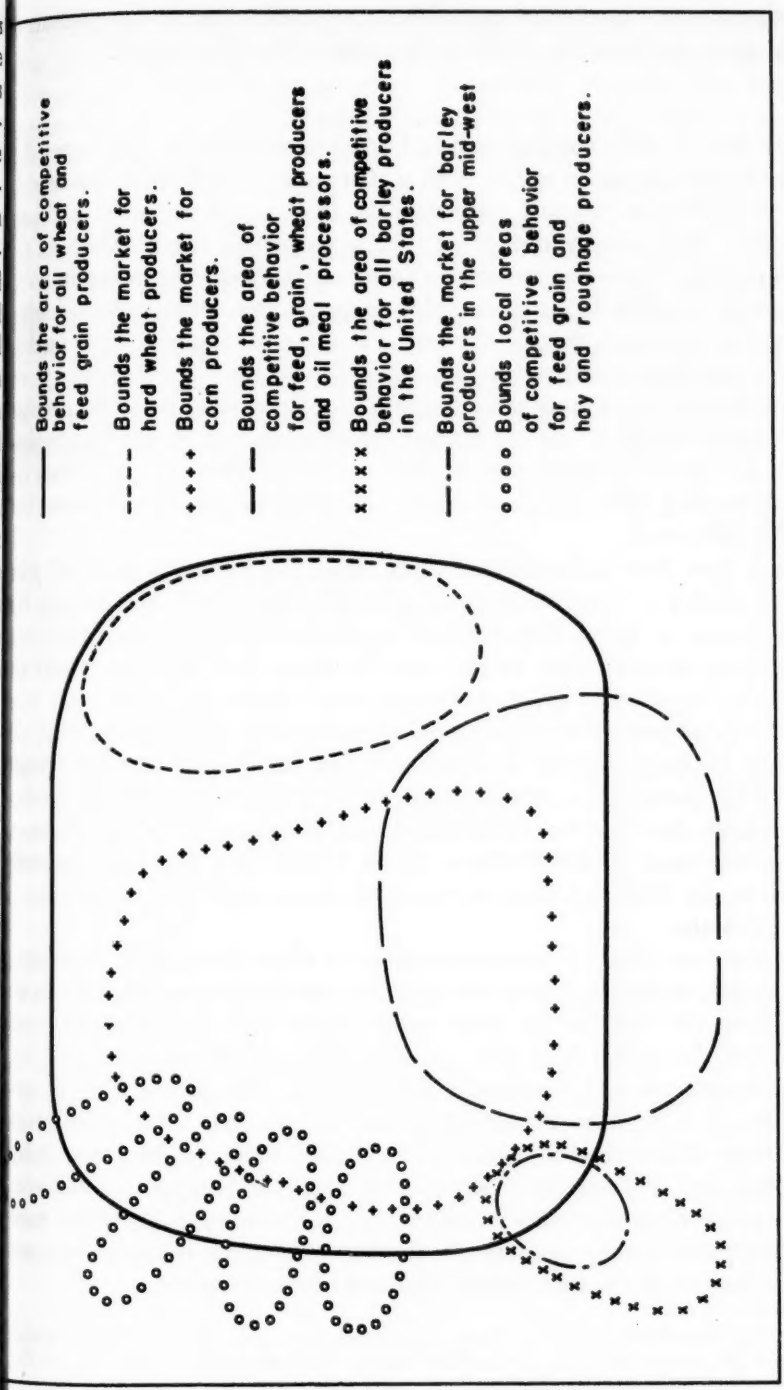
Bounds the area of competitive behavior for all wheat and feed grain producers.
Bounds the market for hard wheat producers.
Bounds the market for corn producers.
Bounds the area of competitive behavior for feed, grain, wheat producers and oil meal processors.
Bounds the area of competitive behavior for all barley producers in the United States.
Bounds the market for barley producers in the upper mid-west
Bounds local areas of competitive behavior for feed grain and hay and roughage producers.

FIG. 3. SUGGESTED AREAS OF COMPETITIVE BEHAVIOR AND MARKET GROUPINGS FOR FEED GRAINS, OIL MEAL, HAY AND ROUGHAGE, BARLEY AND WHEAT COMPLEX

production and marketing methods among producers of these wheats, is what fixes the boundary limits of the market for hard wheat.

V

By way of summarizing, it is a basic presumption of this paper that price formation occurs at the level which we have defined as the market, *not in particular physical marketplaces.* In the case of wheat and hogs we may find only a few buyers in a particular marketplace—in the Minneapolis Grain Exchange, or the terminal livestock market in South St. Paul. But this latter information is really irrelevant and misleading data. For we argue that no one buyer in either of the particular marketplaces just named can pursue a really *independent pricing policy.* If one buyer lowers his offering price below the going market price, he acquires no supply except insofar as market information and/or grade specifications are faulty in some respect. If he raises his offering price above the going market price he is swamped with supplies and cannot make that higher price stick.

It is true that transportation costs measured from the point of price offer, creates a situation wherein a single buyer will not acquire the total supply of the industry, should he raise his offering price above the prevailing market price. In the case of wheat and hogs he would get only the supply of a given producing shed, unless the price offer were unusually attractive. But the supplies forthcoming from a given shed will usually be large enough to overwhelm the single buyer, hence prevent him from pursuing an independent pricing policy. After all, the producing wheat shed for the marketplace, the Minneapolis Grain Exchange, comprises most of the Northern Great Plains; and any hog marketing place in the Midwest, local or terminal, draws from several counties to several states.

In the case, then, of such commodities as hard wheat, hogs, beef cattle, corn, eggs, soybeans, cotton and potatoes, circular power relations do not dominate the markets for those commodities even though there would appear to be evidence of such relations in particular marketplaces (e.g., few buyers, constant percentage acquisitions). The *general case* in agriculture, it is here hypothesized, is one of atomistic markets involving relatively homogeneous commodities.[20] And these markets are linked together by common and overlapping areas of competitive behavior. The areas of competitive behavior become conveyor belts for transmitting price signals through the process of product substitution across wide reaches of the agricultural segment of the economy.

[20] This hypothesis refers to farm product markets prior to processing. Markets beyond the processing stage are another matter. They are characterized by few firms and product differentiation. But we know very little concerning their operation.

In this view the single market does not stand alone as a determiner of either price or quantity; markets are related through the process of substitution, and beyond that areas of competitive behavior are linked together by the process of substitution. Price-quantity determinations assume an overt, tangible form in a particular market as transactions are entered into between a set of sellers experiencing similar production, marketing and organizational phenomena and some set of buyers (or conversely). But the actions of buyers and sellers in a particular market are always influenced *to some degree* by the price signals and substitutional possibilities in other related markets. Hence, we have the compromised conclusion that markets are (1) price-making units, but (2) the price-making forces of a market extend beyond the boundaries of that market and beyond even the boundaries of the area of competitive behavior within which the market falls.

SIMPLIFIED PRESENTATION OF "TRANSPORTATION-PROBLEM PROCEDURE" IN LINEAR PROGRAMMING[1]

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TO DATE, most agricultural economists using linear programming have employed the "general procedure" or "simplex method." Certain agricultural economics problems seem better adapted and more easily solved by the "transportation-problem procedure" or "MODI method."[3]

The "transportation-problem procedure" was conceived to give a minimum transport cost in satisfying a given set of needs from a given set of sources. The need of each location and the capacity of each source were predetermined. Total needs equalled total capacity. Thus, all coefficients of the matrix could be converted to one or zero.

This would seem unduly restricting, but it is not difficult to generalize the procedure to cover a large group of problems where the objective is to give a *minimum cost, or maximum profit,* in satisfying *any set of outputs from* a *given set of inputs.* Any problem meeting the following formal characteristics can qualify:

"(1) One unit of *any* input can be used to produce one unit of *any* output
(2) The cost or margin which will result from conversion of one unit of a particular input into one unit of a particular output can be expressed by a single figure regardless of the number of units converted.
(3) The quantity of each individual input and output is fixed in advance, and the total of the inputs equals the total of the outputs."[4]

Thus, the transportation problem differs explicitly from the general problem in at least two ways. Any input can satisfy any output in the transportation problem, although this is usually not true in the general problem. Also, total inputs must equal total outputs in the transportation problem, but this need not be true in the general problem.[5]

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[1] Purdue Journal Paper No. 1013, approved for publication August 8, 1956.

[2] The authors are especially indebted to their colleague at Purdue University, A. Charnes, who has been instrumental in developing the method illustrated in this article. His helpful suggestions on the manuscript are also appreciated. Acknowledgment is also due Earl W. Kehrberg of the Dept. of Agricultural Economics, Purdue University for his review of the manuscript and worthwhile suggestions.

[3] This distinction between the "general" and "transportation-problem" procedures is made explicitly by Alexander Henderson and Robert Schlaifer, "Mathematical Programming-Better Information for Better Decision Making," *Harvard Business Review,* May-June, 1954, pp. 94-100.

[4] *Ibid.,* p. 98.

[5] Henderson and Schlaifer, *loc. cit.,* the authors illustrate some of these working differences with actual problems.

Koopmans[6] illustrated early use of the "transportation-problem procedure" and Samuelson[7] later showed its relationship to the broader spatial equilibrium problem. Judge[8] has solved with this procedure an interregional competition problem in eggs. The authors[9] have recently completed a somewhat similar study in dairy products. Waugh[10] used a modification of it to award contracts in connection with the school lunch program.

This procedure makes for a much more simple formulation of a given problem than the "general procedure." Often hand calculation will yield answers for sizeable problems.[11] Also, recent improved machine programs developed by A. Charnes at Purdue have made digital computer solution quite simple for this type of problem.

The "general procedure" has been well illustrated in this journal.[12] The "transportation-problem procedure" has not been so illustrated in sources readily available to agricultural economists.[13] Thus, this article will illustrate this procedure in detail. In the same vein as the articles cited above by Heady and Boles, no complicated mathematics will be use.

This procedure can best be illustrated by example. Let us assume an interregional problem of determining the lowest transport cost in satisfying fixed consumption needs of given regions from fixed production levels within the same regions.

Let us suppose that the United States is composed of four regions that are contiguous. Let us choose one point in each region (preferably near the center) that will serve as a point of production for the region and also as a point of consumption for the region. The next logical step

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[6] T. C. Koopmans, "Optimum Utilization of the Transportation System," *Econometrica*, Vol. 17, Suppl. (July 1949) pp. 136-46.

[7] P. A. Samuelson, "Spatial Price Equilibrium and Linear Programming," *The American Economic Review*, Vol. 42, No. 3, June 1952, pp. 283-303.

[8] George G. Judge, *Competitive Position of the Connecticut Poultry Industry—A Spatial Equilibrium Model for Eggs*, Storrs Agr. Expt. Station Bulletin 318, University of Connecticut, January 1956.

[9] M. M. Snodgrass, "Linear Programming Approach to Optimum Resource Use in Dairying," unpublished Ph.D. Thesis, Purdue University, August 1956.

[10] Reported to the authors in letter of June 27, 1955.

[11] The authors found that a matrix 25 by 25 could be handled by hand without too much difficulty. However, if the researcher has little idea as to the general nature of the optimum solution, a 24×24 matrix would be extremely time consuming to solve by hand.

[12] E. O. Heady, "Simplified Presentation and Logical Aspects of Linear Programming Technique," *Journal of Farm Economics*, Dec., 1954, pp. 1035-1048 and J. N. Boles "Linear Programming and Farm Management Analysis," *Journal of Farm Economics*, Feb. 1955, pp. 1-24.

[13] General discussions of this procedure are outlined in Henderson and Schlaifer *op. cit.*, pp. 73-100 and Robert O. Ferguson "Linear Programming," *American Machinist*, April 11, 1955, pp. 121-136.

is to specify a given production and consumption requirement for each region. Suppose that 100 units of the product in question are produced in the whole country. If we eliminate the possibility of storing the commodity, then 100 units will also be consumed. Let us assume the following:

Region	*Production*		*Consumption*	*Surplus*		*Deficit*
1	10		30	—		20
2	15		25	—		10
3	30		25	5		—
4	45		20	25		—
Check	100	=	100	30	=	30

With regard to transportation; let us assume the following structure of rates which are independent of volume or direction:

	Region 1	*Region 2*	*Region 3*	*Region 4*
Region 1	0	2	4	6
2	2	0	6	2
3	4	6	0	4
4	6	2	4	0

It should be noted that there is no cost involved in shipping from any one region to the same region because we assumed the same point in the region for production and consumption. Hence, diagonal rates from upper left to lower right are all zero.

Given these data, the problem becomes one of moving 100 units of production into consumption at a minimum total cost. By inspection of the data, one would guess that Region 1 will consume all 10 of the units it produces since no cost is involved. Similarly, it would be expected that Region 2 will consume all 15 of the units it produces. Since Region 3 and 4 are surplus regions, it would seem likely that they would meet all of their consumption needs from their own production. As a result, then, a guess that only 30 units of the product will move is quite logical. It will be seen later how this process of inspection can cut down considerably the time involved in actually solving the problem.

Next, the formulation of the problem matrix is necessary.[14] To designate the squares in the matrix, the notation x_{ij} is used where i refers to the region of production or origin and j refers to the region of consumption or destination. Thus the sum of the x_{ij}'s would equal 100 as all 100 that are produced are moved into consumption. The following table

[14] For purposes of illustration, a matrix of 4×4 will be formulated including all four states as both producing and consuming states. However, since two are surplus and two are deficit states, a matrix of 2×2 is all that would be necessary to solve the problem.

illustrates the situation where x_{ij} equals the amount (if any) moving from state i to state j.

(A)

x_{11}	x_{12}	x_{13}	x_{14}
x_{21}	x_{22}	x_{23}	x_{24}
x_{31}	x_{32}	x_{33}	x_{34}
x_{41}	x_{42}	x_{43}	x_{44}

Example: The amount in this cell will represent the amount produced and shipped from Region 2 for consumption in Region 4.

The total number of cells in table matrix (A) totals 16 as would be expected; four rows and four columns each with four cells. If we let production be indicated by rows and consumption by columns, and at the same time let P's (production) represent rows and U's, columns (consumption), the following relationships are established:

(B)

$$P_1 = x_{11} + x_{12} + x_{13} + x_{14} = 10$$
$$P_2 = x_{21} + x_{22} + x_{23} + x_{24} = 15$$
$$P_3 = x_{31} + x_{32} + x_{33} + x_{34} = 30$$
$$P_4 = x_{41} + x_{42} + x_{43} + x_{44} = 45$$
$$P_1 + P_2 + P_3 + P_4 = 100 = \sum x_{ij} = \text{Total production}$$

(C)

$$U_1 = x_{11} + x_{21} + x_{31} + x_{41} = 30$$
$$U_2 = x_{12} + x_{22} + x_{32} + x_{42} = 25$$
$$U_3 = x_{13} + x_{23} + x_{33} + x_{43} = 25$$
$$U_4 = x_{14} + x_{24} + x_{34} + x_{44} = 20$$
$$U_1 + U_2 + U_3 + U_4 = 100 = \sum x_{ij} = \text{Total consumption}$$

$$\text{Finally: } \sum_{i=1}^{4} P_i = \sum_{j=1}^{4} U_j = 100$$

The next step is the formulation of a basic solution or, in other words, to formulate a type of solution to the problem that will satisfy the above requirements. It may also be called a first approximation and it will no doubt yield a total cost figure greater than the optimum. The solving for the optimum therefore is nothing more than a series of approximations each of which gives a lesser total cost than the previous.

To formulate a base, or first approximation, it is necessary to fill seven of the 16 cells or x_{ij}'s. The number of cells that must be filled to constitute a basic solution is always obtained by adding the number of rows to the number of columns and subtracting one. In this case, four plus four minus one, equals seven.

The next question is, which seven are chosen for the first approximation? It is here that inspection of the data "pays off"—in guiding the problem solver in making the best first approximation possible. To the extent the researcher has either empirical or theoretical knowledge of his problem, he can hypothesize logical interregional flows. These flows can be

built into the basic solution within certain limits (explained later). A good first approximation saves considerable time in reaching the optimum.

The combination of seven cells chosen must meet certain requirements to be valid. The first requirement is that it must satisfy all row and column requirements designated in (B) and (C) above.

Following are two examples of basic solutions. Included in the upper right of each cell is the appropriate transportation rate.

In example (D), the seven x_{ij}'s or cells in the solution and their amounts chosen were x_{14} (10), x_{24} (10), x_{23} (5), x_{33} (20), x_{32} (10), x_{42} (15), and x_{41} (30). The total cost of this approximation would be the sum of each of the amounts times its particular rate. If we designate the transportation rates by "t_{ij}," then the total cost of this solution would be $\Sigma x_{ij}t_{ij}$ or $(10 \times 6) + (10 \times 2) + (5 \times 6) + (20 \times 0) + (10 \times 6) + (15 \times 2) + (30 \times 6)$ or $60 + 20 + 30 + 0 + 60 + 30 + 180 = \$380$. A quick check shows that this solution meets the requirements of (B) and (C) above.

(D)

					Production ↓
	0	2	4	(10) 6	$P_1 = 10$
	2	0	(5) 6	(10) 2	$P_2 = 15$
	4	(10) 6	(20) 0	4	$P_3 = 30$
	(30) 6	(15) 2	4	0	$P_4 = 45$
Consumption→	$U_1 = 30$	$U_2 = 25$	$U_3 = 25$	$U_4 = 20$	$\sum_{i=1}^{4} P_i = \sum_{j=1}^{4} U_j = 100$

A second requirement that must be met concerns the cells that are *not* chosen as a part of the basic solution. This requirement is best explained in nonmathematical terms by use of an analogy. Imagine the matrix above (D) as a pond of water and each x_{ij} or cell that is one of the seven in the solution as a stepping stone on which one could stand without getting wet. Suppose also the pond was of a sufficiently small size so that one could easily walk from one stepping stone to another. At once it is evident that it would be possible to walk from x_{14} in the upper right or northeast corner of the matrix to x_{41} in the lower left or southwest corner of the matrix without getting wet. It is also pertinent to require

that in making this journey one would never walk diagonally (northwest, southwest, northeast, or southeast) in direction but always either north, south, east, or west. In this particular case, one would walk only south and west.

The combination of seven cells in matrix (D) constitutes a *valid* base if and only if it is possible to accomplish a check for *each* x_{ij} or cell that is *not* a stepping stone. Since seven of the 16 cells are stepping stones, it is necessary to check the remaining nine that are not; namely, x_{11}, x_{12}, x_{13}, x_{21}, x_{22}, x_{31}, x_{34}, x_{43}, and x_{44}. To check a cell, move directly east or west in the same row as the cell that is being checked until a stepping-stone cell is found. Then, if it is possible to move alternately north or south and then east or west to stepping-stone cells until a stepping stone is reached that is in the same *column* as the cell originally being checked, the test for that particular cell is completed. For example to check cell x_{11} in the matrix (D), the first move is to x_{14} (which is in the *same row*), thence south to x_{24}, west to x_{23}, south to x_{33}, west to x_{32}, south to x_{42}, and west to x_{41} where the check is complete because x_{41} is in the *same column* as the cell being checked, x_{11}. It is important to note that it is not necessary to move to an adjacent stepping-stone cell with each move. It is only necessary that a stepping-stone cell be used at the corners or when one is moving from a row to a column or vice versa. It is "legal" to skip over cells to reach a stepping stone at a corner. These skipped cells can be either other stepping-stone cells or empty cells.

Finally, then, the following paths of movement would constitute a final check as to the validity of the base in matrix (D):

(E)

Cell to be checked		*Movement path of check*
x_{11}	—	x_{14} to x_{24} to x_{23} to x_{33} to x_{32} to x_{42} to x_{41}
x_{12}	—	x_{14} to x_{24} to x_{23} to x_{33} to x_{32}
x_{13}	—	x_{14} to x_{24} to x_{23}
x_{21}	—	x_{23} to x_{33} to x_{32} to x_{42} to x_{41}
x_{22}	—	x_{23} to x_{33} to x_{32}
x_{31}	—	x_{32} to x_{42} to x_{41}
x_{34}	—	x_{33} to x_{23} to x_{24}
x_{43}	—	x_{42} to x_{32} to x_{33}
x_{44}	—	x_{42} to x_{32} to x_{33} to x_{23} to x_{24}

In each case, the first stepping-stone cell listed is in the same *row* as the one being checked and the last stepping-stone cell listed in the movement path is in the same *column* as the cell being checked. There is only *one* possible movement path that will give these results. In a large matrix, the path is not always immediately evident as in this simple case.

To illustrate that there is another combination of seven cells that constitutes a basic solution, the following matrix is shown:

(F)

(10) 0	2	4	6	10
2	(15) 0	6	2	15
4	6	(25) 0	(5) 4	30
(20) 6	(10) 2	4	(15) 0	45
30	25	25	20	100

First, compare this matrix with (D) as regards total cost. In (F) above, total cost is $(10 \times 0) + (15 \times 0) + (25 \times 0) + (5 \times 4) + (20 \times 6) + (10 \times 2) + (15 \times 0)$ which totals \$160. This is \$220 less than the cost of (D). Therefore, if this solution is a valid base, it is a much better one to start with.

Check:

(G)

Cell to be checked		*Movement path of check*
x_{12}	—	x_{11} to x_{41} to x_{42}
x_{13}	—	x_{11} to x_{41} to x_{44} to x_{34} to x_{33}
x_{14}	—	x_{11} to x_{41} to x_{44}
x_{21}	—	x_{22} to x_{42} to x_{41}
x_{23}	—	x_{22} to x_{42} to x_{44} to x_{34} to x_{33}
x_{24}	—	x_{22} to x_{42} to x_{44}
x_{31}	—	x_{34} to x_{44} to x_{41}
x_{32}	—	x_{34} to x_{44} to x_{42}
x_{43}	—	x_{44} to x_{34} to x_{33}

This completes the check and establishes the basic solution as valid. Thus, it is a "legal" starting point from which to work towards the optimal. It should be noted that the value of inspection mentioned previously would lead one to use matrix (F) as a basic solution instead of matrix (D).

The next process involves the computation of the marginal *row* and *column* values which will be designated by lower case letters "c" or "r." These fit into the matrix in the following manner:

(H)

r↓ \ c→	c_1	c_2	c_3	c_4	$\downarrow P_i$
r_1	(0) x_{11}	2 x_{12}	4 x_{13}	6 x_{14}	P_1
r_2	2 x_{12}	(0) x_{22}	6 x_{23}	2 x_{24}	P_2
r_3	4 x_{13}	6 x_{32}	(0) x_{33}	(4) x_{34}	P_3
r_4	(6) x_{41}	(2) x_{42}	4 x_{43}	(0) x_{44}	P_4
$U_j\rightarrow$	U_1	U_2	U_3	U_4	$\sum x_{ij}$

To compute these marginal values (r and c), *only* stepping-stone cells are used. In (H) above, those x_{ij}'s that were stepping stones in (F) are circled. One value can be assigned and can be either an "r" or a "c" value. The value assigned can be of any magnitude, however to ease computations, it is most advantageous to assign a zero. Although the zero might be assigned to any r or c value, here it will be assigned to r_1. To compute the remaining marginal values, for each x_{ij} that is a stepping-stone cell, r + c is made equal to t_{ij} (transportation rate). Since the t_{ij} values are known and we have already assigned the value zero to r_1, the rest can be computed in the following order:

1. (c_1) If $r_1 + c_1$ must equal t_{11} then $c_1 = t_{11} - r_1$, or
   $c_1 = 0 - 0 = 0$
2. (r_4) If $r_4 + c_1 = t_{41}$, then $r_4 = t_{41} - c_1$, or
   $r_4 = 6 - 0 = 6$
3. (c_2) If $r_4 + c_2 = t_{42}$, then $c_2 = t_{42} - r_4$, or
   $c_2 = 2 - 6 = -4$
4. (r_2) If $r_2 + c_2 = t_{22}$, then $r_2 = t_{22} - c_2$, or
   $r_2 = 0 - (-4) = 4$
5. (c_4) If $r_4 + c_4 = t_{44}$, then $c_4 = t_{44} - r_4$, or
   $c_4 = 0 - 6 = -6$
6. (r_3) If $r_3 + c_4 = t_{34}$, then $r_3 = t_{34} - c_4$, or
   $r_3 = r - (-6) = 10$
7. (c_3) If $r_3 + c_3 = t_{33}$, then $c_3 = t_{33} - r_3$, or
   $c_3 = 0 - 10 = -10$

The completed matrix including these marginal values is shown below (I).

(I)

r ↓ \ c →	0	−4	−10	−6	↓ P_i
0	(10) 0	2	4	6	10
4	2	(15) 0	6	2	15
10	4	6	(25) 0	(5) 4	30
6	(20) 6	(10) 2	4	(15) 0	45
U_j →	30	25	25	20	100

Now we are ready to make the next approximation and determine how much it will reduce cost. The marginal values were computed by use of the transportation rates in stepping-stone cells by making the two corresponding marginal values equal to the rate. However, if a check is made for the nonstepping-stone cells, various answers result. For example, if for x_{12} we add $r_1 + c_2$, the answer is a -4 which is less than the transportation rate, plus two (t_{12}). For x_{43}, $r_4 + c_3$ is $6 + (-10)$ or -4 which is less than a plus four (t_{43}). For the cells that are not stepping stones the results are:

(J)

For: $x_{12} : r_1 + c_2 = 0 + (-4) = -4$ which is < 2 (t_{12})
$x_{13} : r_1 + c_3 = 0 + (-10) = -10$ which is < 4 (t_{13})
$x_{14} : r_1 + c_4 = 0 + (-6) = -6$ which is < 6 (t_{14})
$x_{21} : r_2 + c_1 = 4 + 0 = 4$ which is > 2 (t_{21})
$x_{23} : r_2 + c_3 = 4 + (-10) = -6$ which is < 6 (t_{23})
$x_{24} : r_2 + c_4 = 4 + (-6) = -2$ which is < 2 (t_{24})
$x_{31} : r_3 + c_1 = 10 + 0 = 10$ which is > 4 (t_{31})
$x_{32} : r_3 + c_2 = 10 + (-4) = 6$ which is $= 6$ (t_{32})
$x_{43} : r_4 + c_3 = 6 + (-10) = -4$ which is < 4 (t_{43})

In (J) above, it is important to note that for all cells except x_{21} and x_{31}, the $r + c$ value is always less than or equal to the t_{ij} value of the cell being checked. If all of the cells in (J) had checked out to be less than or equal to the t_{ij} value of the cell being checked, then our first approximation would have been optimum and no further approximation would be necessary. However, since x_{21} and x_{31} did not check, further reductions in cost can be made. The introduction of either of the cells as stepping stones and the elimination of an existing one would decrease cost.

Since only one cell can be changed at a time, a choice must be made as to which will be brought in as a stepping stone. To choose the one that will bring us the greatest reduction in cost, a check is made to see for which cell the value is greater when the calculation $r + c - t_{ij}$ is made. For x_{21}, the value is $(4 + 0 - 2)$ or 2; for x_{31} it is $(10 + 0 - 4)$ or 6. Therefore the choice is the latter, x_{31}.

The next step is to determine how x_{31} was checked previously in (G). Repeating the movement path for the check on x_{31}, it shows: x_{34} to x_{44} to x_{41}. The stepping-stone cells in this movement path are next assigned plus and minus alternately starting with plus. In this particular case, x_{34} is assigned plus, x_{44}, minus, and x_{41}, plus. Since the values in these cells are 5, 15, and 20 respectively, they are thought of as $+5$, -15, and $+20$. Now, the value that is moved to the new stepping-stone cell (x_{31}) is the smallest plus value, or in this instance the 5 from cell x_{34}. Therefore, x_{31} becomes a new stepping-stone cell and x_{34} is eliminated and now becomes a cell that is *not* a stepping stone. Then, in order that the new matrix will meet the requirements of (B) and (C), each of the other quantities in cells x_{44} and x_{41} must be adjusted. A rule to follow is that for each square that was assigned a plus value, the quantity moved (in this case 5) should be subtracted and for each cell assigned a minus, the quantity moved should be added. In this case, then, the quantity in x_{44} becomes 20 and the quantity in x_{41}, 15.

The reduction in total cost is computed by the formula, $r_3 + c_1 - t_{31}$ times amount moved (5). Thus $10 + 0 - 4$ times $5 = \$30$. Total cost of the first approximation was \$160. Since the cost was reduced \$30, the total cost has been reduced to \$130.

The new matrix is as follows:

(K)

r↓ \ c→	0	−4	−4	−6	↓P_i
0	(10) 0	2	4	6	10
4	2	(15) 0	6	2	15
4	(5) 4	6	(25) 0	4	30
6	(15) 6	(10) 2	4	(20) 0	45
U_j→	30	25	25	20	100

Total cost check: $(10 \times 0) + (15 \times 0) + (25 \times 0) + (5 \times 4) + (15 \times 6) + (10 \times 2) + (20 \times 0) = 0 + 0 + 0 + 20 + 90 + 20 + 0 = \$130$.

From this point, operations already performed are merely repeated. First, new marginal row and column values are computed. This is necessary because they are computed with use of stepping-stone cells and in the new approximation, one stepping stone has been eliminated and a new one added. New marginal values are shown in (K) above.

If the process of (J) above is repeated, it is found that only for x_{21} is the r + c value greater than the transportation rate (4 + 0 > 2). Again, assigning alternate plus and minus values to the movement path (G): x_{22} (15) is plus; x_{42} (10 is minus; and x_{41} (15) is plus. In this case, there are two cells in the movement path that tie for being the smallest plus value (x_{22} and x_{41}, both are +15). Either one can be eliminated. In this case, x_{41} is the better choice. This is because x_{22} will be able to remain in the matrix and t_{22} equals zero.[15]

After adjusting the movement path cells by 15, x_{21} has a value of 15, x_{22} has a value of zero, x_{42} has a value of 25, and x_{41} is eliminated. It should be noted that the value zero in x_{22} is a part of the matrix or constitutes one of the seven cells in the solution. Although it means the same with regard to movement of product as an empty cell, it is different in that it is a part of the matrix and a stepping stone.

At all times, the number of original stepping-stone cells in the basic solution (in this case, seven) must be retained. It is possible to remove only one chosen cell (in this case, x_{41}) with each new approximation. Thus, any other cells that become zero after the adjustments on the movement path are made, must remain as a stepping-stone cell and part of the basic matrix.

To compute further reduction in cost: $r_2 + c_1$ minus t_{21} times 15 = 4 + 0 − 2 × 15 = $30. Cost of second approximation was $130; less $30 = $100, cost of third approximation. The new matrix is in (L) below.

(L)

c→ / r↓	0	−2	−4	−4	↓ P_i
0	(10) 0	2	4	6	10
2	(15) 2	(0) 0	6	2	15
4	(5) 4	6	(25) 0	4	30
4	6	(25) 2	4	(20) 0	45
U_j→	30	25	25	20	100

Total cost check: (10 × 0) + (15 × 2) + (5 × 4) + (0 × 6) + (25 × 2) + (25 × 0) + (20 × 0) = 0 + 30 + 20 + 0 + 50 + 0 + 0 = *$100*.

[15] In larger matrices, the right choice made here may save considerable time. It pays to scan the row and column that pass through the cell in question to see if a larger saving can be made by eliminating another cell. With the selection of the best choice, some of the other possibilities may be eliminated.

New marginal values are shown in (L) above. In checking the empty cells, it is found that in each case $r + c$ is equal to or less than the transportation rate. Thus, the optimum solution has been reached.

COMMENTS

In solving a problem, care should be taken to avoid mistakes that can be costly with regard to time. A mistake has been made if any of the following occur: (1) more than one movement path can be found in checking any cell; (2) more than one value can be computed for any of the marginal values; (3) the formula ($r + c - t_{ij}$ times amount moved) gives an amount for reduction in cost such that when subtracted from the total cost of the previous approximation it does not equal $\Sigma\, x_{ij}\, t_{ij}$; (4) when $r + c - t_{ij}$ does not equal zero for a stepping-stone cell; or (5) at any time when the following relationships are violated:

$$\text{(a)} \quad \sum_{i=1}^{n} = P_i \text{ or } \sum_{j=1}^{m} = U_j$$

$$\text{(b)} \quad \sum_{i=1}^{n} P_i = \sum_{j=1}^{m} U_j = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij}$$

Errors of types (1), (2), and (5) above are serious. The other types of errors will tend to wash out as succeeding approximations are made. However, for the final or optimal solution, all these checks should be made.

The maximum transportation cost or a profit maximizing scheme can be solved with this model. To solve for a maximum necessitates eliminating cells for the opposite reason. For example, in (J) above, cells should be eliminated until the $r + c$ value is always *greater* than or equal to the t_{ij} value of the cell being checked. Although it seems absurd to compute a maximum cost of transportation, in some instances it might be valuable to know the range between the minimum and maximum cost.

DETERMINING THE RELATIVE ECONOMY OF HOME-PRODUCED AND PURCHASED MILK

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WHETHER to operate a one- or two-cow dairy to produce milk for family use or to buy dairy products is a farm and home management problem facing many farm families. They would like to have a basis for determining the circumstances in which money is saved by producing milk for family use rather than buying it, and the extent of the saving. In this paper a model has been developed which relates the cost of producing milk from one or two cows to varying levels of family consumption. For purposes of illustration data primarily for the North Central states have been used. Extension Service personnel or other agricultural consultants counseling with farm families would of course use production and cost data applicable to their state or region.

While factors that determine the cost of producing milk are given especial emphasis here, it is understood that other points may be stressed in counseling with families. Most important of these is helping families determine the milk necessary to meet their nutritional needs.[2] Consumption survey data repeatedly show that families that have home-produced milk use more milk and milk products than those who do not.[3] Due consideration, too, should be given to such nonmonetary factors as the inconvenience of daily caring for the cow and the milk and the extra effort that is necessary to produce products comparable in quality to those from good commercial dairies. On the other hand, weight should also be given the convenience of a milk supply that is close at hand and needs only short periods of refrigeration.

Cost of milk used by the family

Four classes of data are needed to estimate the annual unit cost of the milk used by a farm family. These are (1) the cost of keeping a cow; (2) the amount of milk produced and the monthly distribution of this

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[2] Many publications are available on this subject such as, *Do You Get Enough Milk?* Home and Garden Bulletin No. 47, U.S. Dept. of Agriculture.

[3] For example, results of a survey in the North Central region in the spring of 1952 show that farm families that bought milk used an average of 2.8 quarts per person per week while families that produced milk used 5.1 quarts of fluid milk per person per week. M. Orshansky, C. LeBovit, E. C. Blake, and M. A. Moss, *Food Consumption and Dietary Levels of Rural Families in the North Central Region, 1952.* (In press.)

TABLE 1. PRODUCTION, DISTRIBUTION, AND AMOUNT OF MILK AVAILABLE FOR FAMILY USE FROM A ONE-COW FAMILY DAIRY

Item	Month												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Milk production:													
Distribution....percent	14.7	17.7	15.9	14.2	12.4	9.9	7.1	5.3	2.8	0	0	0	100.0
Quantity.....pounds	684	823	739	660	577	460	330	247	130	0	0	0	4,650
Milk requirement of calf[1].....do.....	400	400	400	0	0	0	0	0	0	0	0	0	1,200
Milk for home use, sale, or surplus:													
Pounds.....	284	423	339	660	577	460	330	247	130	0	0	0	3,450
Quarts (pounds÷2.15)	132	197	158	307	268	214	153	115	61	0	0	0	1,605

[1] Veal calf required 10 pounds milk per pound gain. The average gain is between 1.25 and 1.75 pounds a day.

production; (3) the amount of milk used by the family as whole milk and milk products; and (4) the value, if any, of surplus milk produced.

The annual costs of keeping a cow should include only the cash costs directly connected with the enterprise. These are primarily for feed, health, supplies, and other items needed by the animal. They also include prorated costs associated with the ownership of the animal and any facilities and equipment purchased especially for the enterprise. In most instances labor, pasture, and buildings will not be considered as an expense unless they have an alternative cash use.

For illustration purposes, production costs in terms of 1954 prices and estimates of productivity have been supplied from unpublished data by the Production Economics Research Branch of the Agricultural Research Service. Feed requirements for dairy cows on farms in the North Central states that do not sell milk and production per cow under such conditions are based in this discussion on data for Iowa published by the U. S. Agricultural Marketing Service in Rations Fed to Milk Cows, 1954. These costs of production, no value being given for labor, barn, or pasture, average $103 for the average family-type cow which under such conditions is estimated to produce 4,650 lbs. of milk for a 9-months lactation period.

Morrison's *Feeds and Feeding*[4] provides a basis for estimating the proportion of the total supply that can be expected each month throughout the lactation period. Table 1 illustrates the monthly milk supply available to a family owning a cow producing 4,650 lbs. in nine months. A family that uses a large amount of milk may find it profitable to even out the supply by having two cows that freshen six months apart.

After adding up the cost of keeping a cow or cows, the cost per quart of milk produced can be computed. But the cost for the number of quarts used by the family is the more important consideration and the basis on which the discussion of this paper is made. The amount of

[4] F. B. Morrison, *Feeds and Feeding*, Ithaca, New York: Morrison Publishing Co., 1950.

TABLE 2. MILK SUPPLY, AMOUNT USED AS WHOLE MILK AND FOR CREAM AND BUTTER, AND SURPLUS FROM A ONE-COW FAMILY DAIRY ASSUMING USE OF 59 QUARTS FOR DRINKING AND COOKING AND UP TO 147 QUARTS FOR CREAM AND BUTTER

Item	Month									Total
	1	2	3	4	5	6	7	8	9	
1. Milk available.....quarts.....	132	197	158	307	268	214	153	115	61	1,605
2. Whole milk for drinking and cooking.....do...	59	59	59	59	59	59	59	59	59	531
3. Whole milk for cream and butter.....do....	73	138	99	147	147	147	94	56	2	903
4. Surplus whole milk.....do..... [Line 1−(line 2+line 3)]	0	0	0	101	62	8	0	0	0	171
5. Skim milk[1].....do....	66	124	89	132	132	132	85	50	2	812

[1] Nine-tenths of whole milk for cream and butter.

milk used is a total of the milk for cooking and drinking and for cream and/or butter.

Using average data from the North Central Regional Food Consumption Survey of 1952 made by the Household Economics Research Branch, Agricultural Research Service, Table 2 illustrates how a 3-member family with its own milk supply might plan—59 quarts per month for drinking and cooking, 87 quarts for cream, and 60 quarts for butter, assuming one quart of cream and one pound of butter to be the equivalent of 10 quarts of milk.

In many areas it would be difficult to find a market for the small amount of surplus milk that a family might have. However, the surplus can be fed to livestock, used as a protein alternate for family meals, or converted into cheese and butter for use when the milk production of the cow is inadequate. In the cases of the advantageous use of the surplus milk by the family or for livestock feed the effect is to lower the cost of the home-produced milk used. In this discussion surplus milk will be assumed to be fed to livestock and given a value equivalent to its alternate use as corn. Although it is recognized that surplus milk substitutes for corn as livestock feed at a diminishing rate, the small amount of daily surplus and the assumption of several livestock units to consume it minimizes the problem. According to Morrison,[5] a quart of whole milk is equal to about 0.012 bushels of corn as feed for livestock, and a quart of skim milk is equal to about 0.0008 bushels.

Using the examples given in tables and text the production cost per quart for all the milk produced would be $0.064 ($103 divided by 1,605 qts.). For the illustrative family that plans to use up to 206 quarts per month, 1,434 quarts will be used. Valuing the surplus whole milk and

[5] *Op. cit.*

skim milk by Morrison's formula, and with corn at $1.40 per bushel the 171 quarts of whole milk surplus are worth $2.90 and the 812 quarts of skim milk, $8.92.

If the value of the surplus whole milk is credited against the cost of all the milk used and the value of skim milk is credited against the cost of producing cream and butter, the cost per unit of product used would be about as follows: The 1,434 quarts of whole milk used by the family would cost about $100 or $0.07 per quart. This, then, is the cost of each of the 59 quarts per month consumed for drinking and cooking. The cost per unit of cream or butter is 70 cents less the value of the skim milk. The byproduct of a quart of cream or pound of butter is 9 quarts of skim milk valued here at $0.011 per quart. This makes the net cost per quart of cream or pound of butter about 60 cents at this level of milk consumption.

By similar calculation a family using only 100 quarts of milk per month and having one cow would be paying about $0.10 per quart for the whole milk used. Cream or butter made from any part of this 100 quarts would cost $0.90 per quart or per pound.

Comparisons of costs of production and retail prices

The proportion of milk used as whole milk and for cream or butter affects the amount of surplus whole milk or skim milk, and consequently affects the cost of products used. The cost of producing milk used for cooking and drinking should be compared with the retail price of whole milk. The cost of producing cream and butter should be compared with the retail price of these products. In 1954 the retail price of whole milk was $0.20 per quart in the North Central area compared with a cost of $0.07 per quart to produce the milk consumed under the assumptions stated in the preceding examples. In addition the family used up to 147 quarts per month for cream and butter. The cost of these products was about $0.60 per quart of cream and per pound of butter, respectively, and should be compared to their retail price of $1.11 per quart for cream and $0.78 for butter.[6]

Cost of milk at various levels of consumption with one and two cows

With any cow or an average producer the cost per quart to the family of each quart of milk used at any planned level of consumption can be calculated. Such calculations using the production cost figures presented above are shown in figure 1. A separate curve has been drawn to show the cost of milk used if the surplus has no value. Figure 2 shows a comparison of the cost of producing the milk consumed from one cow and

[6] Prices paid by farm families for dairy products are from the North Central survey in 1952 adjusted for changes in prices from 1952 to 1954.

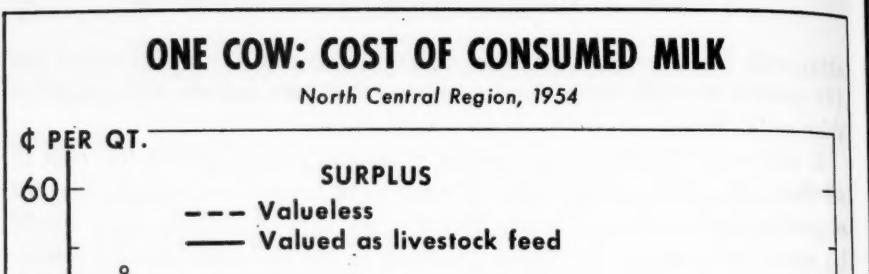
ONE COW: COST OF CONSUMED MILK
North Central Region, 1954
¢ PER QT.
60
40
20
0
SURPLUS
Valueless
Valued as livestock feed
0
100
200
300
PLANNED LEVEL OF MILK CONSUMPTION (QT. PER MONTH)
COST PER QUART BASED ON 4650 POUNDS PRODUCTION PER YEAR; NO CHARGE FOR BARN, PASTURE OR FAMILY LABOR

FIG. 1

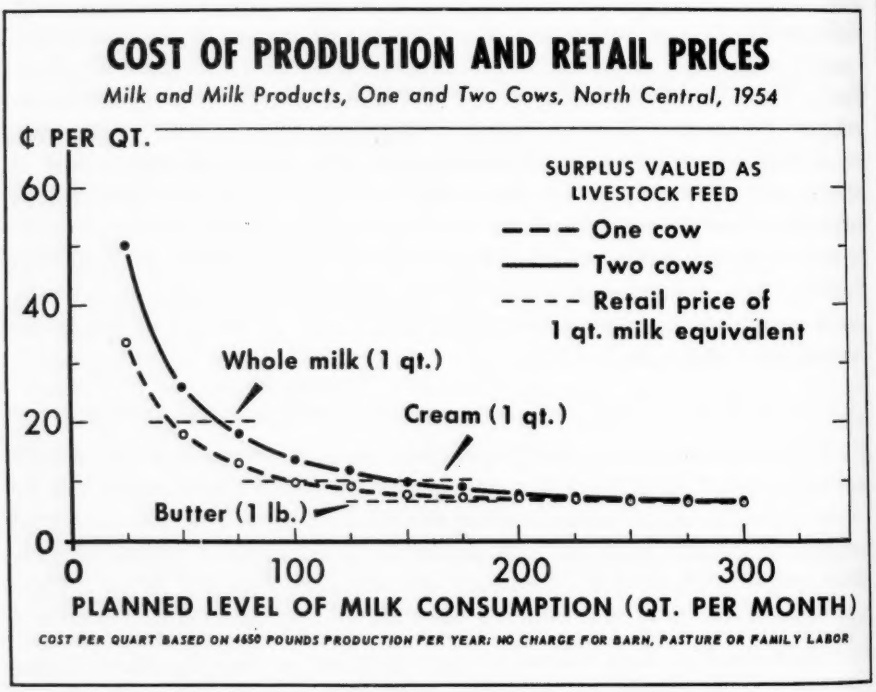
COST OF PRODUCTION AND RETAIL PRICES
Milk and Milk Products, One and Two Cows, North Central, 1954
¢ PER QT.
60
40
20
0
SURPLUS VALUED AS LIVESTOCK FEED
One cow
Two cows
Retail price of 1 qt. milk equivalent
Whole milk (1 qt.)
Cream (1 qt.)
Butter (1 lb.)
0
100
200
300
PLANNED LEVEL OF MILK CONSUMPTION (QT. PER MONTH)
COST PER QUART BASED ON 4650 POUNDS PRODUCTION PER YEAR; NO CHARGE FOR BARN, PASTURE OR FAMILY LABOR

FIG. 2

two cows at various levels of consumption. The cost per quart used, at the same level of consumption, is higher for two cows except at the higher levels of consumption. The greater quantity of surplus milk from two cows at lower levels of consumption causes more of the milk to be valued below the cost of production thus raising the cost of the milk used.

The points at which it is a matter of indifference for the farm family to produce or purchase milk and milk products can be determined from Figure 2. To realize a gain, the family with one cow must consume more than 45 quarts per month as whole milk, or with two cows, 75 quarts or more. However, it is too expensive at this level of consumption to keep a cow to provide milk for butter and cream. If the family can use 110 quarts with one cow or 175 quarts with two cows, it will realize a gain from producing milk for drinking, cooking, and for cream. Not until the 200-quart level of milk consumption is reached with one cow, or 250 quarts with two cows is the use of milk for butter profitable. In each case, however, we are assuming that the skim milk is being used for livestock feed. If the skim milk is used as cottage cheese, which gives a higher return than livestock feed, the curve would move to the left thus making it profitable to keep the cow for making these products at a somewhat lower level of consumption. Or it can be assumed that since the only alternative use of the skim milk is for livestock feed, the cottage cheese can be produced for, in this case, 4 cents per pound (4 quarts skim milk to make one pound cottage cheese times $0.01, the value of the milk as livestock feed).

These examples serve to illustrate the fact that with any given quantity of milk produced—the greatest saving is for the family that can use all the milk produced.

Keeping two cows extends the time milk is available

One of the advantages of having two cows is the assurance of a milk supply for a 12-month period. The extent to which the milk supply from a cow having moderate or low milk production meets the requirements at various levels of consumption is shown in Table 3. For the 3-member family of our illustration that uses about 200 quarts per month, one cow producing 4,650 pounds of milk will provide approximately all the milk for only 4 months of the year; for an additional 3 months more than 80 percent of the milk required is available; for 1 month 50 to 79 percent is available and for 1 month 20 to 49 percent is available, while for 3 months there is no home milk supply. On the other hand, with two cows all the milk required is available for 12 months at this level of consumption. But as pointed out earlier there will be more surplus milk

TABLE 3. NUMBER OF MONTHS THAT PRODUCTION IS EQUAL TO CONSUMPTION PLAN WITH ONE OR TWO COWS

Quarts of milk consumed per month	Number of months that the milk supply provides the stated proportion of planned consumption							
	With one cow					With two cows		
	100 percent of plan	80–99 percent of plan	50–79 percent of plan	20–49 percent of plan	None	100 percent of plan	80–99 percent of plan	50–79 percent of plan
	Producing 4,650 pounds of milk for 9 months							
25	9	—	—	—	3	12	—	—
50	9	—	—	—	3	12	—	—
75	8	1	—	—	3	12	—	—
100	8	—	1	—	3	12	—	—
125	7	1	1	—	3	12	—	—
150	6	2	—	1	3	12	—	—
175	4	3	1	1	3	12	—	—
200	4	3	1	1	3	12	—	—
225	3	1	4	1	3	10	2	—
250	2	3	3	1	3	8	4	—
275	2	1	4	2	3	8	4	—
300	1	1	4	3	3	4	4	4
	Producing 3,800 pounds of milk for 9 months							
25	9	—	—	—	3	12	—	—
50	9	—	—	—	3	12	—	—
75	8	—	1	—	3	12	—	—
100	6	1	1	1	3	12	—	—
125	5	1	2	1	3	12	—	—
150	3	2	3	1	3	12	—	—
175	3	—	4	2	3	12	—	—
200	2	1	3	3	3	9	1	2
225	2	1	2	4	3	6	4	2
250	1	1	3	4	3	2	6	4
275	0	2	2	5	3	—	6	6
300	0	2	1	6	3	—	6	6

and the cost of producing the milk actually used will be somewhat higher.

At a lower level of production, say 3,800 pounds of milk, one cow would provide 200 quarts of milk for only 2 months; two cows, however, would provide this amount for 9 months.

The model and illustration presented in this paper are proposed as a means of helping families decide the practicability of owning one or two cows for home milk production. Persons counseling with families will want to prepare charts using applicable production data from their own area and comparing the cost of milk used with local prices for dairy products. Using such charts facilitates the calculation of the cost of the milk at any level of consumption. Aided by a table on expected adequacy of the milk supply (example, table 3) and by judicious counseling on the use of the surplus skim milk as well as whole milk, a family may be helped to choose the most suitable source of the family milk supply.

USE OF PHOTOGRAPHS IN CONSUMER PREFERENCE STUDIES OF PORK*

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Purpose of the Study

CONSUMERS' preferences for different characteristics in pork chops were to be studied. One approach was to be a survey of households in which housewives were to be asked, among other things, to rank chops of three fatnesses according to their preferences. In order to obtain preference statements from household meat buyers, the question arose whether actual chops, photographs of the chops, or other representations should be shown during the interviews. Color transparencies were finally chosen for use in the survey of households.

The purpose of this paper is to present the procedure that led to the decision to use photographs rather than actual meat samples. There were a number of advantages readily apparent in using photographs:

1. Given a fixed survey budget, a larger sample[1] of households could be visited if photographs rather than actual meat chops were used. In the survey, household meat buyers were to be interviewed within a period of two weeks. Six interviewers were to be used. Assuming that a set of chops could be used only for one day, it would take $3 \times 2 \times 6 = 36$ chops per day for meat samples of 3 chops each, replicated once. The appearance of chops cannot be predicted until the loins are cut open. If the actual meat samples were to be used, it would be necessary to purchase many loins each day and cut them open in order to locate enough chops representative of each type (fatness). This would add greatly to the cost. Furthermore, it would be difficult to keep and carry samples of meat from house to house for even one day in good condition. On the other hand, photographs need to be made but once and do not change in appearance from hour to hour.

2. Individual chops differ in color, shape, characteristics of bone-surface showing, amount and distribution of fat, etc. With photographs each interviewer can have pictures of the same set of chops, thus holding constant, for each type shown to respondents, all the variables mentioned

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[1] In the survey, 500 sample households were visited.

above. Obviously, if meat rather than photographs were to be used in the survey, the closest that two interviewers could come to having identical-appearing chops would be for the second interviewer to have chops that were mirror images (from adjacent positions in the loin) of those carried by the first. However, the variables mentioned could only be held constant while both sets stayed fresh.

3. With photographs, the chops used in the study can be selected more objectively. For example, a large number of chops may be photographed. Then they can be rendered and the weight of fat, lean and bone computed. Then photographs of three chops representative of fat, medium and lean can be selected from this large sample. They can have known differences in fat and lean percentage and similar bone percentage, shape and color.

4. In addition, with photographs the survey could be repeated, getting directly comparable results, if this should ever be desired, for the photographs are not so perishable as meat samples.

5. With photographs, it would be possible for each interviewer to replicate in order to test a respondent's consistency in two rankings of the same set of chops.

Test of Photos Versus Chops

Notwithstanding these advantages, it was decided not to use photographs if it could be shown that housewives gave their preferences less consistently when ranking photographs than when ranking actual chops.

A test was designed to determine whether a comparison of housewives' rankings on photographs of three samples of chops with their rankings of the original chops would indicate as much consistency as the comparison of their rankings of mirror-image chops with those of the original chops. Each mirror-image chop was cut from a position adjacent on the loin to its original chop.

For the test, the procedure described below was followed:

Some 90 loins were cut open just behind the last rib and sorted into three classes according to meatiness. A representative loin was then selected from each class or type (fat, medium, meaty).

1. Two adjacent half-inch thick *loin* chops were cut from each of the three loins selected and kept in their original uncut position.

2. Each group of two chops was peeled apart so that the surfaces that were originally together were facing up. This presented two chops, identical mirror images of each other, with the same areas and colors of bone, muscle and fat showing. This was done for each of the three loins.

3. The chops were then identified with a symbol placed beside each and photographed individually, and finally individually wrapped in

cellophane. The same steps were taken to obtain paired sets of rib chops from each loin.[2]

4. To present the loin (or rib) chops to the housewife for ranking, two nine-inch dinner plates were used as trays. On each plate were placed three cellophane-wrapped chops, one from each class of loin, each chop still the same side up as originally laid out in step 2. Round plates were used to eliminate position bias on the trays.

For both the loin and the rib chops, there were two plates, one of which was called the original and the other the replicate. Each chop on the original plate had its mirror image on the replicate plate.

The first test was made in a nearby city of about 12,000 population (Town A). In this case, no attempt to get a representative sample of households was made other than asking the interviewers to pick three or four representative sections. Two interviewers were used, one taking the two rib-chop plates and the other taking the two loin-chop plates.

Each housewife was shown the "original" plate and asked to rank the three chops as "best," "middle," or "poorest." Then this plate was put away and the "replicate" plate was produced and each housewife was asked to rank the replicate chops.

A few days later these same housewives were revisited and color transparencies of the three chops on the "original" plate were shown. These were ranked and put away. Then transparencies of the three chops on the "replicate" plate were produced for ranking and the housewife ranked them.

The interviewer with the rib chops obtained 20 initial interviews on May 6, 1955. She was able to complete 17 of these a few days later using photographs of the rib chops. Eighteen completed schedules were obtained with loin chops.

The next week the procedure was repeated with different chops and photographs in a nearby town of about 4,000 (Town B). In this case, city blocks were chosen at random and interviewers were given instructions as to objective selection of start and stop points in the selected blocks. The interviewer with the rib chops completed 25 matched interviews and the interviewer with the loin chops completed 26 matched interviews.

For each chop type in each town three comparisons were made during the analysis:

(1) Ranking of Meat set A (original three chops) vs. ranking of Meat set B (replicate three chops).

(2) Ranking of Meat set A vs. ranking of Photo set A (color transparencies of original three chops.

[2] Part of the center of a pork loin contains ribs. Thus a set of "rib" and "loin" (no rib) chops were taken from the same loin.

TABLE 1. METHOD OF MEASURING INCONSISTENCY

		Meat A		
		Best	Middle	Poorest
Meat B	Best	0	1	2
	Middle	1	0	1
	Poorest	2	1	0

(3) Ranking of Meat set B vs. ranking of Photo set B (color transparencies of replicate three chops).

Table 1 illustrates how inconsistency was measured. Assume a housewife's inconsistency in ranking Meat A vs. Meat B is being measured. If she ranked a chop or photo on plate A and its replicate on plate B both as "best," another chop or photo on plate A and its replicate on plate B both as middle and the last chop or photo on plate A and its replicate on plate B both as poorest, this housewife received a score of 0 for inconsistency for each of the three comparisons. Thus, it did not matter which one was chosen as "best" as long as she was consistent.

When one chop or photo was ranked middle on its plate and its replicate on the other plate was ranked as poorest or best, an inconsistency score of 1 was given the respondent for that "comparison."

When one chop or photo was ranked as poorest and its mate on the other plate was ranked as best, an inconsistency score of 2 was given for that "comparison." Each respondent indirectly made three comparisons at an interview by ranking an original and a replicate set of chops or photographs. Thus, for each judgment of an individual respondent, one of six situations was possible. These are shown in Table 2 for the example, Meat A vs. Meat B.

Table 2 shows that a completely consistent pair of rankings scores zero and a completely inconsistent pair of rankings scores four.

Under the assumption that the respondent is unable to consistently rank the chops—i.e., for random or guesswork rankings—each of the above six scores will, in the long run, occur with equal frequency and

TABLE 2. THE SIX POSSIBLE SCORES, ONE OF WHICH A RESPONDENT MIGHT MAKE IN RANKING MEAT A AND MEAT B

		Meat A																		
		B	M	P	B	M	P	B	M	P	B	M	P	B	M	P	B	M	P
Meat B	Best	X	—	—	X	—	—	—	X	—	—	X	—	—	—	X	—	—	X
	Middle	—	X	—	—	—	X	X	—	—	—	—	X	X	—	—	—	X	—
	Poorest	—	—	X	—	X	—	—	—	X	X	—	—	—	X	—	X	—	—
		$m_a=0$			$m_b=2$			$m_c=2$			$m_d=4$			$m_e=4$			$m_f=4$		

hence the expected value of her judgment scores would be 1/6 ($m_a + m_b + \ldots m_f$) = 16/6 = 2 2/3.

For each of the three comparisons, two tests were made:

(1) Whether or not the average scores of the respondents were significantly smaller than the expected score of 2 2/3, i.e., whether there was some significant consistency in their rankings.

(2) Whether or not the actual scores obtained for the meat-photo comparisons indicated a significantly higher inconsistency than that for the meat-meat (miror image) comparisons.

Inconsistency scores were computed for each comparison, location and chop type by use of the following formula: $\bar{m} = \frac{\Sigma m_i}{n}$ when m_i is an individual's inconsistency score and n is the number of completed interviews for the location and chop type. See Table 1 for method of getting the individual inconsistency score.

In Table 3, column I shows the average inconsistency scores of Meat set A vs. Meat set B, column II those for Meat set A vs. Photo set A and column III those for Meat set B vs. Photo set B. The values marked n.s. (not significant) indicate that in three of the twelve situations the average score of the respondents did not differ significantly from the expectation score of 2 2/3 = 2.67 at the 5 percent probability level. All three average inconsistency scores were significantly different from the expectation score.

TABLE 3. AVERAGE INCONSISTENCY SCORES BY COMPARISONS, LOCATION AND TYPE OF CHOP

	I MA vs. MB	II MA vs. PA	III MB vs. PB	n
Town A Rib Chops	0.76	0.71	0.88	17
Town A Loin Chops	1.56	0.89	2.56 n.s.	18
Town B Rib Chops	1.28	1.68	1.52	25
Town B Loin Chops	2.03 n.s.	2.80 n.s.	1.19	26
Average	1.47	1.66	1.51	

n=number of completed interviews in one town for one chop type.

Significance of the scores were measured by use of the standard t formula:

$$t = \frac{(\bar{m} - 2\frac{2}{3})}{s_m/\sqrt{n}} \quad \text{where} \quad s_m = \sqrt{\sum (m_i - \bar{m})^2/(n-1)}$$

Table 3 has shown that the first test gave significantly smaller scores than might be expected from random ranking in nine out of 12 cases. However, the operative question is: Can photographs substitute for

meat? The second test, as stated previously, was to show whether or not the average scores obtained from the meat–photo comparisons indicated a significantly higher inconsistency than those for the meat-meat (mirror image) comparisons.

To test this, "t" values using the following formula were computed and are shown in Table 4.

$$t = \frac{\bar{d}}{s_d/\sqrt{n}} \quad \text{where} \quad s_d = \sqrt{\sum (d_i - \bar{d})^2/(n-1)}$$

The inconsistency score of an individual in one town for one chop type, computed as follows, was called d_i:

½ times (score for Meat set A vs. Photo set A *plus* score for Meat set B vs. Photo set B) *minus* score for Meat set A vs. Meat set B.

That is:

$$d_i = \frac{(m_{iMA-PA} + m_{iMB-PB})}{2} - m_{iMA-MB}$$

The d_i, then, is the difference between a respondent's average meat-photo inconsistency and her meat-meat (mirror image) inconsistency. Then $\bar{d}$ is the average of all d_i from one chop type in one town and, as before, n is the number of completed interviews in one town for one chop type.

By using the "t" just defined, Table 4 answers the important question. The meat-photo comparisons do not show a significantly higher inconsistency score than the meat-meat comparisons. In these cases the photographs used were as good as the mirror image chops in getting people's rankings to coincide with their rankings of an "original" set of chops.

Discussion

The t test is known to behave satisfactorily even if distributions deviate considerably from normal. However, the distribution of the d_i's has been examined for non-normality and none was indicated.

TABLE 4. AVERAGE VALUE OF d_i BY LOCATION AND TYPE OF CHOP

	$\bar{d}$	t	n
Town A—rib chops	0.03	0.13	17
Town A—loin chops	0.56	0.13	18
Town B—rib chops	0.32	0.98	25
Town B—loin chops	−0.04	−0.11	26
Combined	0.09	0.58	86
Combined for rib chops	0.20	0.44	42
Combined for loin chops	0.00	0.00	44

It is possible that, when photographs were used rather than meat samples, differences in preferences for the different chops were lessened or even intensified, but not enough to destroy the consistency of the rankings.

To get at this problem it might have been better to have obtained these same rankings indirectly, perhaps as follows:

Have each respondent rate the 3 chops individually on a scale of:

5 excellent
4 very good
3 good
2 fair
1 poor

with instructions to rate each chop the same if she wished.

Then, have the photographs of these chops rated by the *same* scale by the *same* respondents. The analysis made in this study could have been made by comparing (ranking) the orders of the ratings. In addition some idea about whether or not photographs unduly lessen or intensify preferences or differences in preferences could be obtained by comparing numerical ratings of a chop and its photo and by comparing the numerical difference in ratings of two photos with the numerical differences in ratings of the two chops. This may, however, amount to asking for finer distinctions than the interviewees could make. Since simple rankings were used in this test they were also used in the survey that was conducted later.

Uncertainty about the relationship of visual appearance, important in merchandising, to ultimate eating satisfaction raises questions about the use of photographs or of raw chops in a survey seeking statements of consumer preferences. Also in the case of well-trimmed chops, size of the eye-muscle area may be the most important quality with respect to both visual and eating satisfaction. If so, photographs and preference statements would possibly be of less value than tests of retail sales in a study of consumer preferences since the cost per chop is different for a one-fourth pound chop for example than for a one-fifth pound chop. The shopper must not only prefer but also be willing to pay for the larger chops, if such a preference is to be expressed.

Other Work

H. W. Schultz has conducted a comparison of responses to photographs versus responses to beef cuts. He used three-dimensional color pictures displayed in TDC stereo-viewers and concluded that, "when sufficiently large numbers of people are used in a consumer survey, they will probably show the same pattern of preference for fresh beef whether

they are tested with fresh cuts or with three-dimensional pictures of the cuts."[3]

Implications

The results of the test discussed in this paper suggest that when it is desired to determine preferences for non-uniform perishable items that are judged to a large extent by their surface characteristics, color photographs should be considered.

Also, a promotional and educational program for pork producers, in particular should consider the use of photographs rather than carcasses. If farmers are to be shown the waste attending production of over-fat hogs, this may possibly be shown as effectively by photographs as by an expensive refrigerator-truck display of carcasses, even in cases where the demonstrator is fortunate enough to find carcasses that properly illustrate his point.

APPENDIX: PHOTOGRAPHIC TECHNIQUE[4]

The meat cuts were photographed individually on a corrugated blue paper background with two lights placed on either side at an angle of about 45 degrees from the horizontal at the center of the meat cut. Blue was used because of its color compatibility with the reddish meat color. The two lights illuminated the meat cuts with little or no objectionable shadow and glare spots on the surface of the meat.

An advantage of using photographs in the survey was that a copy of the original could be prepared for each interviewer. However, producing these copies from the originals presented problems. The use of ordinary copying procedures resulted in objectionable color shifts even when modified color-developing procedures were used. Also the reds in the meat cuts became too saturated and the blue background became too dark causing excess over-all contrast. In short, the meat portrayed by the photographic *copies* did not appear natural.

The technique finally used to produce copies from the original photographs was that of back masking the original by the method used to obtain a principal mask as described in the Kodak Color data book, *Color Separation and Masking*. The back masks used had a density of about 25 percent of the density range of the original. After registering the mask with the original, the combination was projected, 1 to 1, through a Harrison 1/8 B color correction filter on a Saltzman #30-WRC enlarger onto a 4″ × 5″ sheet of Ektachrome type B film with an exposure time determined by trial. The exposed films were developed normally. The quality and exactness of the copies produced by this technique proved satisfactory for use by the interviewers.

[3] H. W. Schultz, *Use of Three-Dimensional Color Pictures in Consumer Preference Studies of Beef*, Miscellaneous paper No. 25, Oregon Agricultural Experiment Station.

[4] By Louis A. Facto, *Agricultural Experiment Station Photography Laboratory*, Iowa State College, Ames, Iowa.

FARMER'S CHOICE OF HOG MARKETS*

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WHY DO some farmers choose to sell hogs to local outlets in the production area while others choose to ship longer distances and to sell through terminal facilities? Many have assumed that farmers would use those markets that would net them the greatest dollar returns. And if farmers did not act in this way, it was because of imperfect and faulty market information. Improve and correct the collection and dissemination of market news, and farmers would change to the more economically advantageous markets.

However, is the "economically rational man" concept an adequate framework? Are the "economically irrational" decisions really a result of lack of market knowledge? Or, are these decisions quite rational if the total value framework of the individual is recognized? Commercial market researchers in their studies of buying motivation have pretty well concluded that the narrow confines of "economic man" will not give them meaningful answers. Man as a maker of consumer decisions is part economic, part psychological, and part sociological. Are farmers' market decisions also made by such a complex individual?

The Design of the Study

Some studies of this problem have found the principal reason given for selling at a particular outlet was that it was the "nearest" or "most convenient." In order to hold both the distance factor and the alternative market choices constant, the sample of 178 farmers was a neighborhood cluster type with the clusters being randomly drawn from a limited area in central Indiana. The area and farmers sampled had the following characteristics:

1. Terminal market facilities were available to all farmers 40 to 60 miles away, and at least two "local" outlets less than 25 miles away were available to all farmers.
2. The area was one in which the hog enterprise was the major one on the majority of the farms. The average farmer sold hogs four times a year with each sale averaging 45 hogs.

The analysis, therefore, is substantially one of the actions of commercial hog raisers in a limited community facing the same alternative marketing possibilities.

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** Special acknowledgement is also made of Dr. R. L. Stucky who aided in the questionnaire design. Indiana Experiment Station Journal Paper.

Hog-Selling Activity

The various aspects of the selling activity of these farmers can be summarized as follows:

1. Most farmers had made their hog sales during the year studied, June 1954-June 1955, to one market exclusively. Fifty-eight percent had sold only on the terminal market, 19 percent had sold exclusively to one local market. Only 23 percent had sold to more than one market—usually a terminal-local market combination.
2. One-third of the farmers used their own truck in transporting their hogs—69 percent of the farmers had gone to the market to witness the sale of their hogs.
3. Interest in general conditions of the hog market was high—nearly one-third of the farmers claimed to be following the market every day. However, there was not a great interest in comparing the alternative markets as the date of sale approached—nearly half of the farmers obtained information from only one market prior to sale. Thus, interest was evidently one of trying to correctly time the sale and not one of ascertaining the relative advantages of different places of sale.
4. The farmer had a rather limited view of the marketing alternatives available to him. Although 11 local outlets and the one terminal market were easily available to serve the area, farmers when asked what their alternatives were usually gave only two markets.

Farmers' Attitudes Toward Markets

The farmer had some rather interesting opinions about the markets he believed available to him. (Table 1.) It is recognized that "a lot," "some" and "not much" are indefinite and undefinable. However, such information does give an insight into an individual's attitude scale. It does permit the adding of like attitude intensities even though each individual may be using a different bench mark for his judgement. And as will be shown, the relative intensity of opinion and attitudes apparently are very important in the choice of type of market.

TABLE 1. FARMER OPINION OF DIFFERENCES AMONG AVAILABLE LIVESTOCK MARKETS

Factors	Degree of difference			
	Percent of farmers			
	"A lot"	"Some"	"Not much"	"Do not know"
The price quoted	7	63	29	1
Sorting practices used in determining price	26	36	31	7
Marketing charges	23	52	20	7
Honesty and fair dealing	3	13	76	8
Amount of competition on the market	39	39	18	4

Farmers were widely split in their beliefs as to the differences among markets in sorting or grading, the amount of marketing charges and the extent of competition. However, farmers believed that markets did differ and one market was "best" in certain circumstances. More than two-thirds of the farmers believed that one market was better than another for sows than for barrows and gilts and that one market was better for high quality hogs and another for low quality hogs.

These differences, however, fairly well cancelled themselves out in the farmer's final analysis. Table 2 shows that nearly half of the farmers believed there was less than 25 cents a hundredweight difference in the net returns (after market costs, transportation charge, and shrink) received from different markets. Shrinkage during shipping evidently was not widely considered by the farmer. Nearly 40 percent of the

TABLE 2. FARMER OPINION OF NET DIFFERENCE AFTER COSTS IN HOG RETURNS AMONG MARKETS AT ANY ONE TIME

Difference	Number of farmers
¢/cwt.	Percent
0– 25	43
26– 50	31
51–100	17
Over 100	2
Don't know	7

farmers had no opinion as to the amount of shrink that occurred, and the remainder held highly diverse opinions.

Factors Influencing Choice of Markets

On the basis of the markets used, there were basically three categories of farmers: (1) those who sold only on the terminal market, (2) those who sold only to a single local outlet, and (3) those who sold on two or more markets.

Past studies of this general area have shown that local market prices were usually below those paid at the terminal market by amounts ranging from 20 to 40 cents a hundredweight. The marketing charges at the terminal market were approximately 60 cents a head. Local market charges varied ranging from no direct charge up to approximately 25 to 30 cents a head. In addition, at least one of the local markets had a publicized campaign on to buy and pay for hogs on a graded basis.

In each of the limited neighborhood clusters, some farmers sold terminally and others direct. So it would appear that the same absolute levels of prices and costs were interpreted differently by different farmers. This leads to the hypothesis that farmers evaluate whatever comparative price and cost information within some other framework

than strict dollar comparisons. In addition, many farmers, either from choice or inability to do so, did not attempt market-to-market comparisons when they sold their hogs. Evidently the farmer's background, opinions and biases entered into his decision making. What was the relationship of these possible factors to the market choice made? As a point of departure farmers were asked directly why they sold where they did. The reasons given could be classified in order of their importance as follows:

For Selling Terminally	*For Selling Locally*
More buyers	Nearest market
Price	Price
Net returns greater	Net returns greater

What do these mean? With the exception of "more buyers" and "nearest market," the same reasons are given for patronizing both types of markets. This was particularly confusing since, as shown in Tables 1 and 2, farmers professed to believe there was not a great deal of difference among markets in either price or net returns.

Also, the meaning of "nearest market" was not clear. In some of the neighborhoods, the preferred local outlet was not "nearest." In some instances farmers living side by side chose different markets as "nearest." In all areas there was at least one market within 10 to 20 miles, and in this day and age such distances certainly are not prohibitive. It was hypothesized that "nearest" really meant that the farmer owned his own truck and wanted to use it or that he wanted to accompany his hogs to market and not take much time. However, there was no significant relation between these two activities and the farmer's choice of a local or terminal market.

Since the reasons given by farmers for their choices seemed to be conflicting, three other major types of factors were analyzed for their possible relationship to the farmer's market choices. These were the farm enterprise characteristics, socio-economic status characteristics, market attitudes and opinions.

Enterprise Relationships to Choice

It might be hypothesized that one type of market was best for farmers with smaller operations and selling smaller lots and that farmers recognized this advantage in making their market selection. However, there was no significant difference in the size of individual consignment made to terminals and those sold to the local market. There was also no relationship between the type of market used and the size of the total farm operation as measured by gross dollar income.

There was a difference between the type of market used and the weight of hogs (excluding sows) sold. Lighter hogs were sold locally. This, however, does not indicate that the farmer chose a market because it was most advantageous for the weight of hogs currently available to be sold. Nearly 8 or 10 farmers took all their hogs to one market exclusively. Under these circumstances, more likely the farmer chose his market for other reasons and then *adapted* his management to what seemed to be the weight desired by *that* market.

Socio-economic Status Relationships to Choice

It might also be hypothesized that the various socio-economic characteristics of a farmer were influential in the opinions held and market choices made. In exploring this hypothesis, data were collected on the age of the farmer, the number of years he had been in farming, the number of years he had been in his own neighborhood, and the level of his education. In addition, various indexes were devised in the attempt to measure the farmer's activity and leadership in community affairs, his interest in continuing adult education and his exposure to magazines, newspapers, radio and television. No clear relationships were found between any of these factors and the choice of markets made. Those who marketed to local outlets as compared with those selling on terminals were not different in these respects. Various levels of age, education, farm experience, and community experience and participation were found in the groups that patronized either type of market.

Market Opinion Relationships to Choice[1]

As seen from above, farmers did hold varying opinions as to the amount of difference among different markets. Were these factors related to the choice of direct or terminal outlets? Some of them apparently were and some apparently were not. The relationships of these market attitudes to the market choices can be summarized briefly as follows:

1. There was no relationship between the believed amount of net return difference (Table 2) and the final selection of markets. This probably does not mean that farmers consciously chose a market that they believed returned them less. Rather it probably indicates that different farmers evaluate the same net return differently. This, of course, is in agreement with the reason of "net returns greater" appearing as a reason of choice for both types of markets.

[1] All reported relationships were significant at the 5 percent level as determined by the chi-square test for independence.

TABLE 3. RELATIONSHIPS BETWEEN OPINIONS OF PRICE DIFFERENCE AMONG MARKETS AND TYPE OF OUTLET USED

Farmer opinion of difference	Outlet used		
	Terminal only	One local only	Multiple markets
	Percent of Farmers		
"Not much"	59	33	8
"Some"	54	21	25
"A lot"	69	8	23

2. There was a wide diversity of opinions as to sorting practices and the majority of farmers did believe that some markets were better than others as outlets for sows and high quality hogs (Table 1). There was no relationship, however, between these opinions and the type of market outlet patronized. Some evidently believed local outlets best on these points—others evidently believed terminals best.
3. There was no relationship between the different opinions of "fair dealing" and where hogs were sold.
4. There was a significant relationship between the opinions of price difference and where hogs were sold. As the opinion of the amount of difference increased, the exclusive use of local outlets decreased and the multiple use of outlets increased (Table 3). When farmers believed "a lot" of difference they increased their use of terminal facilities. This relationship clouds still farther why "price" was given by farmers as a main reason for choosing both terminals and local markets.
5. There was a significant relationship between the opinion of market-charge difference and the choice of market types. When farmers were very conscious of a lot of difference in marketing charges, they tended to increase their patronage of local outlets and decrease their use of the terminal facility (Table 4).
6. The bias or state of mind concerning the "amount of competition" was significantly related to market choice. As the opinion of the amount of difference in competition rose, the preference for terminal outlets increased. This was especially true as the opinion shifted

TABLE 4. RELATIONSHIP BETWEEN OPINIONS OF MARKETING-CHARGE DIFFERENCE AMONG MARKETS AND THE TYPE OF OUTLET USED

Farmer opinion of difference	Outlet Used		
	Terminal only	One local only	Multiple markets
	Percent of Farmers		
"Not much"	78	11	11
"Some"	52	30	18
"A lot"	49	19	32

from "some" to "a lot" of difference (Table 5). As might be expected there was a positive relationship between belief of competition difference and belief of price difference. However, it was evident that "price difference" and "competition difference" were not different terms for the same thing. Reference again to Table 1 will show that the opinion of difference in competition was more widely held than the opinion of difference in price.

TABLE 5. RELATIONSHIP BETWEEN OPINIONS OF COMPETITION DIFFERENCES AMONG MARKETS AND THE TYPE OF OUTLET USED

Farmer opinion of difference	Outlet used		
	Terminal used	One local only	Multiple markets
	Percent of Farmers		
"Not much"	47	31	22
"Some"	51	29	20
"A lot"	72	9	19

Obviously from the foregoing findings, there was no particular "type" of farmer (as could be characterized by his hog enterprise, farming operation, or other personal and social factors) who chose one particular type of market over another. Also, some of his market opinions apparently were not too influential on his choice. But on the other hand, the opinions concerning price, marketing charges and competition that he held were related to the market choice he made. Were all of these three opinions of equal importance? Were they held by farmers in any particular combinations? When the outlet decisions of each farmer in relation to that particular farmer's opinions about these three markets factors were analyzed some interesting results were secured (Table 6).

TABLE 6. THE RELATIONSHIP OF DIFFERENT OPINION GROUPS TO THE TYPE OF MARKET OUTLET USED

Market opinions held	Outlet Used		
	Terminal only	One local only	Multiple markets
	Percent of farmers		
(Distribution of total sample)	58	19	23
I. Not much—some" competition difference; "Some—A lot" charge difference; "not much—some" price difference	34	38	28
II. "A lot" competition difference; "some—A lot" charge difference; "not much—some" price difference	68	8	24
III. "Not much—some" competition difference; "not much" charge difference; "not much—some" price difference	80	8	12
IV. "A lot" competition difference; "not much—some—A lot" charge and price differences	91	0	9

A close study of the opinion groups and the outlets used (Table 6) substantiates the proposition that the three opinion areas that were individually related to market choices were not of the same level of power. Obviously, Group I holds the opinions that from their individual relationships (Tables 3, 4, 5) should give the most local market bias—and it does. Group III relaxes the marketing-charges opinion restrictions and the use of terminals rises sharply. Group II and IV are particularly interesting since farmers in these groups hold all shades of opinions about charges and price differences, but they believe there is a great deal of competition differences. In both instances, the terminal bias is high. It would appear that the opinions held about prices alone are not of major importance in affecting market use. (This supposition sheds some light, then, on the reason for price appearing as farmer's reason for choice of both local and terminal markets.) If accompanied by a lack of sharp feelings about the degree of competition, the attitude concerning level of marketing charges seems important. However, if it was believed that there was a sharp difference in competition, this opinion seemed to over ride all other attitudes in turning farmers toward the terminal market.

Implications

If the foregoing analysis is indicative of the general picture, it helps explain the behavior of farmers who might be judged irrational on strict price and cost grounds. They are perhaps quite "rational" when their own framework of value and opinions are considered.

It would seem doubtful that the improvement of the market news and information system would by itself obtain a change in farmers' behavior. Many of the farmers here studied did not utilize all of the information now available on their potential alternative outlets. When asked why they did not seek this information their reply usually was "never considered it," or "not interested." If market studies demonstrated that more shopping around among alternatives would be to the farmer's advantage, then some of the "mental road blocks" to this activity must be removed. One of these blocks apparently is the opinion of what competition is, how it works, and what the results of its working are. Additional exploration is in order on just what is involved in a farmer's opinion of a "lot of competition." This information then could be used in making our educational programs in marketing more effective.

BIASES IN CERTAIN PRODUCTION INDEXES[1]

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PROFESSOR COCHRANE has recently presented in the *Journal of Farm Economics* a revised version of his hypothesis concerning the irregular shifting of the aggregate agricultural supply function to the right as a result of the adoption of new technology.[2] Briefly his thesis is that the function is almost perfectly inelastic; further, it holds steady for a period of years of constant technology, jumps sharply to the right during a period of improving technology, then repeats the process.

To subject this hypothesis to empirical testing, some method is needed to identify periods of constant technology and those of changing technology. In his most recent article, Cochrane computed an "index of production efficiency" as the ratio of the index of volume of farm marketings and home consumption to an index of total agricultural inputs.[3] Professor Schultz performs a similar analysis. He computes two indexes of the physical volume of agricultural inputs and compares changes in the volume of inputs with changes in the volume of agricultural production for sale and home consumption.[4]

The computation and evaluation of these measures of inputs, outputs and technology is a problem in index numbers. The purpose here is to investigate the biases in these indexes. First, we need the following notations:

q_0^i = base-period price of factor i.
q_1^i = given-period price of factor i.
p_0^j = base-period price of product j.
p_1^j = given-year price of product j.
x_0^j = base-period output of j-th product.
x_{1p}^j = given-period output of j-th product at point E_p or e_p on the graph. When it is clear from the context which point is referred to, the subscript p will be dropped.

[1] Journal Paper No. J-3023 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project No. 1318. Contribution from Iowa Agricultural Experiment Station as a collaborator under North Central Regional cooperative project entitled "Adapting the Marketing Structure for Dairy Products to Changing Patterns of Utilization and Changing Technology." The author gratefully acknowledges the help he received from Prof. J. A. Nordin.

[2] "Conceptualizing the Supply Function in Agriculture," *Journal of Farm Economics*, Vol. 37, Proceedings Number, Dec., 1955, pp. 1161–76. For the earlier versions, cf. "Farm Price Gyrations—An Aggregative Hypothesis," *Journal of Farm Economics*, Vol. 29, May, 1947, pp. 383–408 and *An Analysis of Farm Price Behavior*, Progress Report 50, Agricultural Experiment Station, Pennsylvania State College, 1951.

[3] From the use made of this index it can be presumed that it should reflect the impact of changes in received technology and advances in the state of knowledge concerning the use of accepted technology. To emphasize the apparent nature of the index it will be referred to as an index of technology. It might also be called a productivity index.

[4] *The Economic Organization of Agriculture* (McGraw-Hill Book Co., New York), 1953, pp. 99–109.

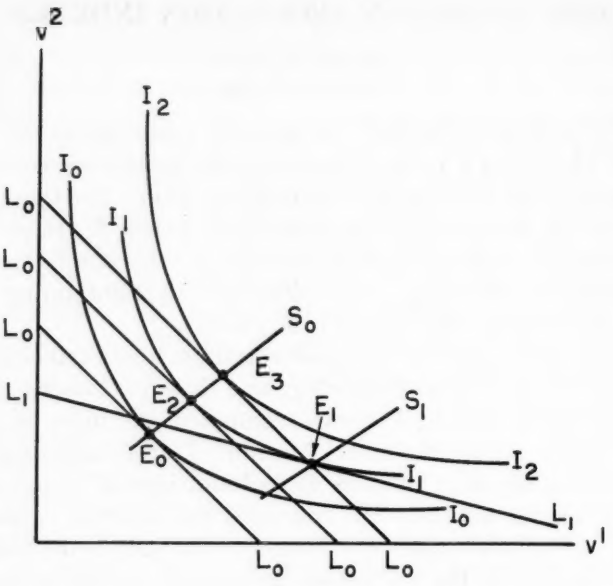

FIG. 1

v_0^{ij} = amount of factor i used to produce commodity j in the base period.
v_{1p}^{ij} = amount of factor i used to produce commodity j in the given period at the output indicated by point E_p or e_p. When it is otherwise clear which point is referred to the subscript p will be dropped here also.

I. *Constant Relative Prices*

As a first step, we take the simple case of one product and two factors, as indicated in Figure 1, where the slope of the line L_0L_0 indicates the factor price ratio in the base period and E_0 indicates the equilibrium output of x_0^1 in the base period. Assume that in the given year the relative factor prices are the same and the equilibrium output is at E_2. Since we are assuming constant technology and homogeneous units of the factors, if the index of technology is valid it must equal unity. That is,

$$\frac{x_1^1}{x_0^1} \div \frac{\sum_i q_0^i v_1^{i1}}{\sum_i q_0^i v_0^{i1}} \equiv 1, \quad i = 1, 2. \tag{I.1}$$

This means,

$$\frac{x_0^1 + dx^1}{x_0^1} \div \frac{C_0^1 + dC^1}{C_0^1} = 1 \tag{I.2}$$

or,

$$\frac{dx^1}{x_0^1} = \frac{dC^1}{C_0^1}. \tag{I.3}$$

This means that the percentage increase in output must be exactly equal to the percentage increase in total cost. We have to assume an odd production function to make this equality hold at all points. In the case of pure competition with no change in product price, this means,

$$\frac{dR}{R_0^1} = \frac{dC}{C_0^1}, \text{ since } R_0^1 = px_0^1 \text{ and } dR = pdx^1, \tag{I.4}$$

which is true only for small deviations about the long-run equilibrium point.

In the slightly more complicated case of two products and two factors it is still true that the percentage change in revenue must equal the percentage change in total cost in order for the index to indicate no change in technology.

$$\begin{aligned} 1 &= \frac{\sum_j p_0^j x_1^j}{\sum_j p_0^j x_0^j} \div \frac{\sum_i \sum_j q_0^i v_1^{ij}}{\sum_i \sum_j q_0^i v_0^{ij}} = \frac{R_0 + dR}{R_0} \div \frac{C_0 + dC}{C_0} \\ &= \frac{\sum_j p_0^j x_0^j + \sum_j p_0^j dx^j}{\sum_j p_0^j x_0^j} \div \frac{\sum_i \sum_j q_0^i v_0^{ij} + \sum_i \sum_j q_0^i dv^{ij}}{\sum_j \sum_i q_0^i v_0^{ij}}, \end{aligned} \tag{I.5}$$

$$i = 1, 2; j = 1, 2.$$

In the usual case, the index will be $\lesseqgtr 1$ according as the firm is operating at outputs above, at, or below the point of minimum average total cost. By extending the range of summation for i and j, it is easily seen that this argument can be generalized to cover the case of $m(>2)$ products and $n(>2)$ factors. It is possible that the base period for product prices may differ from the base period for factor prices. This creates no difficulty, however, since it is only necessary to compute cost using factor-price base-period prices and to compute revenue using product-price base-period prices.

II. *Variable Relative Factor Prices*

If we relax the restrictive assumption that relative prices remain constant, this type of analysis is of little help. Previously it was valid since dR and dC were function of dx^j and dv^i only, as was the index of technology. When relative prices vary there is no longer this correspondence between the derivatives and changes in the index. To study this situation we will again use Figure 1, in which L_0L_0 indicates the base-period factor-price ratio and S_0 indicates the expansion path under this price structure. Output in the base period of x_0^1 is given by point E_0; we could also draw graphs representing $x_0^2, \cdots, x_0^m$ and factor inputs $v_0^{31}, \cdots, v_0^{n1}, v_0^{12}, \cdots, v_0^{n2}, \cdots, v_0^{nm}$.

This and the next section will proceed on the assumptions of constant technology, constant knowledge about the best utilization of that tech-

nology and homogeneous production functions of degree one. The latter assumption means that marginal cost is constant along the expansion path. The purpose of these assumptions is to simplify the problem and to set up conditions most favorable to the validity of the technology index. The assumptions will be relaxed later.

Suppose that in the given year the factor price ratio is given by line L_0L_4. The expansion path is now S_1 and x_1 will be along this line, say at point E_1. The base-weighted index of physical volume of inputs is

$$\frac{\sum_i \sum_j q_0{}^i v_{11}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}},$$

which in turn equals

$$\frac{\sum_i \sum_j q_0{}^i v_{13}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}}.$$

The index of inputs will have the same value at point E_1 is at point E_3. But it hardly seems logical to say that the physical volume of inputs has increased by the same amount in moving from $E_0$to E_1 as in moving from E_0 to E_3. It would seem more logical to argue that the movement from E_0 to E_2 along S_0 clearly represents an increase in the physical volume of inputs and the movement along I_1I_1 from E_2 to E_1 represents substitution among factors. The two movements might be called the "input expansion effect" and the "input substitution effect," respectively, the two being analogous to Hick's income and substitution effects in the theory of consumer behavior.[5]

At point E_1, the new factor combination valued at base-year prices represents an amount of money sufficient to attain point E_3 (i.e., $\sum_i q_0{}^i v_{11}{}^{i1} = \sum_i q_0{}^i v_{13}{}^{i1}$) and $x_{13}{}^1 > x_{11}{}^1$. The technology index for x^1 is now

$$\text{(II.1)} \qquad \frac{p_0{}^1 x_{11}{}^1}{p_0{}^1 x_0{}^1} \div \frac{\sum_i q_0{}^i v_{11}{}^{i1}}{\sum q_0{}^i v_0{}^{i1}} < \frac{p_0{}^1 x_{13}{}^1}{p_0{}^1 x_0{}^1} \div \frac{\sum_i q_0{}^i v_{13}{}^{i1}}{\sum_i q_0{}^i v_0{}^{i1}} = 1.$$

Point E_1, which represents an efficient use of resources gives a smaller value to the index than does point E_3, which represents an inefficient use of resources under the new price structure. Further, point E_1 gives a smaller value to the index than does point E_2, which would require a larger expenditure on inputs than does point E_1 for the same output. The optimum resource combination indicates a decline in technology while the non-optimum resource combination shows a constant technology. Rather an unhappy situation: In order for the index to remain constant when relative prices vary, farmers must operate at non-optimum points. It may be, of

[5] *Value and Capital* (2nd Ed.; Clarendon Press, Oxford), 1950, pp. 26–32.

course, that due to the dynamics of the adjustment process, farmers do operate at non-optimum points. But, in order to maintain the value of the index, they must operate at specific inefficient points: those along S_0.

By the same sort of reasoning, for any product k

$$\text{(II.2)} \qquad \frac{p_0{}^k x_{11}{}^k}{p_0{}^k x_0{}^k} \div \frac{\sum_i q_0{}^i v_{11}{}^{ik}}{\sum_i q_0{}^i v_0{}^{ik}} < \frac{p_0{}^k x_{13}{}^k}{p_0{}^k x_0{}^k} \div \frac{\sum_i q_0{}^i v_{13}{}^{ik}}{\sum_i q_0{}^i v_0{}^{ik}} = 1, \; k = 2u, \cdots, m.$$

Further

$$\frac{\sum_j p_0{}^j x_{11}{}^j}{\sum_j p_0{}^j x_0{}^j} \div \frac{\sum_i \sum_j q_0{}^i v_{11}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}} < \frac{\sum_j p_0{}^j x_{13}{}^j}{\sum_j p_0{}^j x_0{}^j}$$

$$\text{(II.3)} \qquad \div \frac{\sum_i \sum_j q_0{}^i v_{13}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}} = 1,$$

since each term in the numerator of the first ratio is less than the corresponding term in the denominator and also less than the corresponding term in the numerator of the second ratio. The same conclusions hold for the index based on aggregate output as for the index based on a single product.

III. *Variable Relative Factor and Product Prices*

Common base periods

Now suppose that relative product prices vary also, and refer to Figure 2, in which T_0T_0 represents the transformation curve in the base period, i.e., the transformation curve attainable with the resources actually used in the base period. The slope of r_0r_0 gives the relative product prices in the base period. The point e_0 indicates outputs $x_0{}^1$ and $x_0{}^2$ in the base period corresponding to the points E_0 in Figure 1 and the corresponding (undrawn) figure for x^2. The slope of r_1r_1 gives the price ratio in the given year and point e_1 represents the outputs $x_1{}^1$ and $x_1{}^2$ in the given year, corresponding to the points E_1 in Figure 1 and the corresponding (undrawn) figure for x^2.

T_1T_1 differs from T_0T_0 because the change in relative factor prices changes the proportions among the amounts of the various inputs used. Changes in these proportions can usually be expected to change the transformation curve. Here the new transformation curve is drawn to intersect the old curve, although it is not necessary that a change in the proportions among various inputs leads to an intersection of the new and the original functions. At any rate, the conclusions are independent of the exact shape and position of the given-year curve.

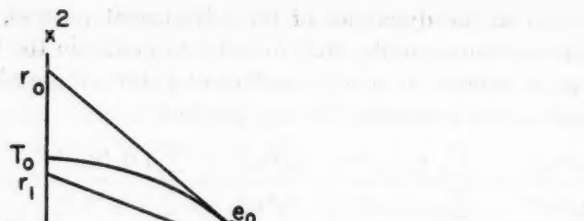

FIG. 2

The r_0r_0 price line through e_1 is tangent to a lower transformation curve at e_4;

$$\text{(III.1)} \qquad \sum_i \sum_j q_0{}^i v_{11}{}^{ij} > \sum_i \sum_j q_0{}^i v_{14}{}^{ij}$$

since this lower transformation curve can be attained by reducing each physical input. The monetary value of the output at e_1 is the same as the monetary value of the output at e_4.

$$\text{(III.2)} \qquad \sum_j p_0{}^j x_{11}{}^j = \sum_j p_0{}^j x_{14}{}^j.$$

Changes in relative product prices also lead to a downward bias in the index of technology.

Summarizing:

$$\text{(III.3)} \qquad \begin{aligned} 1 = \frac{\sum_j p_0{}^j x_{13}{}^j}{\sum_j p_0{}^j x_0{}^j} \div \frac{\sum_i \sum_j q_0{}^i v_{13}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}} > \frac{\sum_j p_0{}^j x_{11}{}^j}{\sum_j p_0{}^j x_0{}^j} \\ \div \frac{\sum_i \sum_j q_0{}^i v_{11}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}} < \frac{\sum_j p_0{}^j x_{14}{}^j}{\sum_j p_0{}^j x_0{}^j} \div \frac{\sum_i \sum_j q_0{}^i v_{14}{}^{ij}}{\sum_i \sum_j q_0{}^i v_0{}^{ij}}, \\ 1 = A > B < C, \qquad A \gtreqless C. \end{aligned}$$

The technological index (B) is biased downward because of changes in relative factor prices and/or changes in relative product prices. The bias is at least as large as the largest bias that would exist if either change occurred alone. The biases cannot offset each other, but they may cumulate.

This conclusion, assuming the same base period for both product and factor prices, would appear to apply approximately to the index of technology for the years since 1939. The index of farm marketings and home consumption uses weighted average 1947–49 farm prices as weights for

1940 to date and 1935–39 prices as weights for 1910–39.[6] The index of volume of production inputs used by Cochrane is the one published in *The Economic Organization of Agriculture.*[7] This index uses 1946–48 factor prices as weights for all years.

Different base periods

What happens when the base period for product prices differs from the base period for factor prices? Let the slope of r_0r_0 still give the relative product prices prevailing during the base period for factor prices, let r_br_b indicate the relative product prices prevailing during the base period for product prices and let r_1r_1 represent the relative product prices during the given period for factor prices. Consider first the situation in which r_br_b coincides with r_1r_1, that is, the base period for product prices is the same as the given period for factors, This would correspond to the 1935–39 period and is shown in Figure 3, where e_1 represents the same combination of outputs as does e_1 in Figure 2.

Restating (II.1),

$$\text{(III.4)} \qquad \frac{p_b{}^1x_{13}{}^1}{p_b{}^1x_0{}^1} \div \frac{\sum_i q_0{}^iv_{13}{}^{i1}}{\sum_i q_0{}^iv_0{}^{i1}} = A = 1.$$

Since:

$$\text{(III.5)} \quad x_{13}{}^1 > x_{11}{}^1, \quad x_{14}{}^1 = x_0{}^1 \text{ and } \sum_i q_0{}^iv_0{}^{i1} > \sum_i q_0{}^iv_{14}{}^{i1},$$

$$\text{(III.6)} \quad 1 = A > \frac{p_b{}^1x_{11}{}^1}{p_b{}^1x_0{}^1} \div \frac{\sum_i q_0{}^iv_{11}{}^{i1}}{\sum_i q_0{}^iv_0{}^{i1}} > \frac{p_b{}^1x_{11}{}^1}{p_b{}^1x_0{}^1} \div \frac{\sum_i q_0{}^iv_{11}{}^{i1}}{\sum_i q_0{}^iv_{14}{}^{i1}}$$

$$1 = A > B > C.$$

Generalizing from one to several products would replace the superscript 1 by the superscript j and the single summation by a double summation. The differences in relative product prices between the base period for product prices and the base period for factor prices now impart an upward bias to the index (B). However, this upward bias is not sufficient to offset the downward bias due to relative factor price changes and the index has a net downward bias.

In periods when r_br_b does not coincide with r_1r_1, the index of technology still has a downward bias, due to the changes in relative factor prices. The changes in relative product prices have 1 of 3 effects: They (1) partially offset the downward bias due to changes in relative factor prices, (2) increase the downward bias beyond that due to these changes, or (3) leave the bias

[6] *Measuring the Supply and Utilization of Farm Commodities, New Indexes, 1924–54.* U.S.D.A., A.M.S., Agriculture Handbook 91, 1955. p. 38.

[7] *Op. cit.*, pp. 107–8. Prof. Cochrane informed the author by personal letter that this is the index he used.

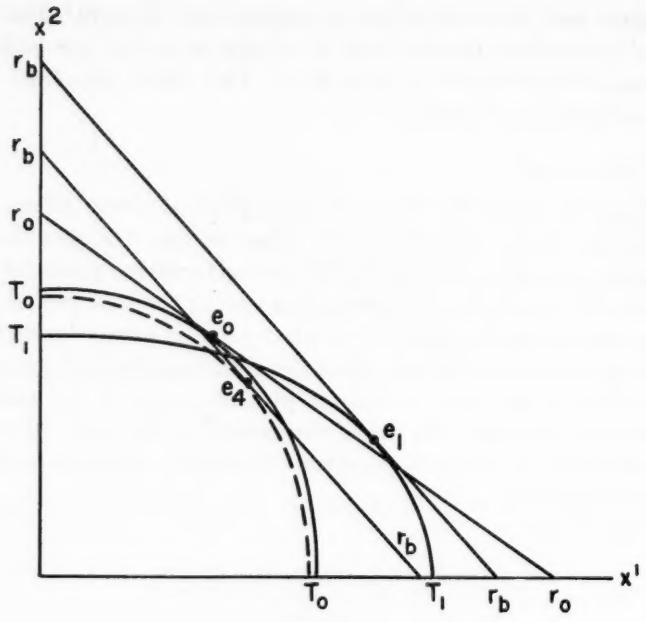

FIG. 3

exactly equal to that caused by variations in relative input prices. This situation can be analyzed by the use of a graph which is similar to Figure 3 except that the slopes of $r_b r_b$ and $r_1 r_1$ are not equal.

IV. *Different Production Functions*

The discussion has proceeded thus far on the assumption of homogeneous production functions of degree one. This assumption may be fairly realistic when all inputs are measured as amounts actually used rather than as stock available for use. However, the measurement of the amounts of buildings, equipment and labor used is difficult. It is probably correct to assume that the index of inputs measures some inputs as the stock available rather than as the amounts used.

If the function is homogeneous of degree less than one, the preceding conclusions still hold. If the production function is homogeneous of degree greater than one, the index of technology may be $\gtrless 1$ depending upon whether the amount by which the degree exceeds one is, or is not, sufficient to offset the downward bias brought about by relative price changes.

V. *Technological Change*

Common base periods

Consider now what may happen to the index of technology when there is a definite improvement in accepted technology or when there is an improvement in knowledge concerning the use of accepted technology, again on the assumption that the improved technology gives rise to constant

returns to scale. Suppose first that the improvement does not affect the shape of the isoquants but merely shifts the isoquant representing a particular output towards the origin. Under this condition we can use Figure 1 to represent the situation both before and after the change, with the understanding that each isoquant represents a greater output under the improved technology.

Consider first a situation in which technology in the given year represents an improvement over technology in the base period. Let:

${}^*x_0{}^j$ = output of product j at point E_0 after the change in technology.

${}^*x_{1p}{}^j$ = given period output of product j at point E_p after the change in technology.

${}^*v_0{}^{ij}$ = amount of input i used to produce good j with the improved technology.

${}^*v_{1p}{}^{ij}$ = amount of input i used to produce product j in the given period at the point E_p.

Since:

$$(V.1)\quad {}^*x_{13}{}^1 > {}^*x_{11}{}^1, \quad {}^*x_0{}^1 > x_0{}^1, \quad \sum_i q_0{}^i {}^*v_{11}{}^{i1} = \sum_i q_0{}^i {}^*v_{13}{}^{i1} \text{ and } \sum_i q_0{}^i v_0{}^{i1} = \sum_i q_0{}^i {}^*v_0{}^{i1};$$

$$(V.2)\quad \frac{p_0{}^1 {}^*x_{11}{}^1}{p_0{}^1 x_0{}^1} \div \frac{\sum_i q_0{}^i {}^*v_{11}{}^{i1}}{\sum_i q_0{}^i v_0{}^{i1}} < \frac{p_0{}^1 {}^*x_{13}{}^1}{p_0{}^1 x_0{}^1} \div \frac{\sum_i q_0{}^i {}^*v_{13}{}^{i1}}{\sum_i q_0{}^i v_0{}^{i1}} > \frac{p_0{}^1 {}^*x_{13}{}^1}{p_0{}^1 {}^*x_0{}^1} \div \frac{\sum_i q_0{}^i {}^*v_{13}{}^{i1}}{\sum_i q_0{}^i {}^*v_0{}^{i1}} = 1,$$

$$B < C > A = 1.$$

The index of technology (B) may be either $\gtrless 1$ even though there is a definite change in technology. Just as the conclusion reached in Section II could be generalized from one to many products, so can this one be generalized. It is immediately apparent that the index may also be $\gtrless 1$ when the production function is homogeneous of degree greater than one, or less than one.

Suppose, however, there has been an improvement in technology between the given year and the base period. Then

$$(V.3)\quad \frac{p_0{}^1 x_{11}{}^1}{p_0{}^1 {}^*x_0{}^1} \div \frac{\sum_i q_0{}^i v_1{}^{i1}}{\sum_i q_0{}^i {}^*v_0{}^{i1}} < \frac{p_0{}^1 x_{13}{}^1}{p_0{}^1 {}^*x_0{}^1} \div \frac{\sum_i q_0{}^i v_{13}{}^{i1}}{\sum_i q_0{}^i {}^*v_0{}^{i1}} < \frac{p_0{}^1 {}^*x_{13}{}^1}{p_0{}^1 {}^*x_0{}^1} \div \frac{\sum_i q_0{}^i {}^*v_{13}{}^{i1}}{\sum_i q_0{}^i {}^*v_0{}^{i1}} = 1,$$

$$B < C < A = 1.$$

In this case and in the case of declining returns to scale, the index (B) would definitely indicate an improvement in technology. However, if the productuion functions exhibit increasing returns to scale the index may or may not show an improvement in technology.

Suppose, however, that the technological improvement between the base

period and the given period causes the shape of the isoquants to change, but the production function with the improved technology is homogeneous of degree one. This kind of situation is illustrated in Figure 4.

$$(V.4) \qquad p_0{}^{1*}x_{14}{}^1 > p_0{}^{1*}x_{11}{}^1, \qquad p_0{}^{1*}x_{05}{}^1 \gtreqless p_0{}^{1*}x_0{}^1.$$

$$(V.5) \qquad \frac{p_0{}^{1*}x_{11}{}^1}{p_0{}^1x_0{}^1} \div \frac{\sum_i q_0{}^{i*}v_{11}{}^{i1}}{\sum_i q_0{}^iv_0{}^{i1}} \gtreqless \frac{p_0{}^{1*}x_{14}{}^1}{p_0{}^{1*}x_{05}{}^1} \div \frac{\sum_i q_0{}^{i*}v_{14}{}^{i1}}{\sum_i q_0{}^{i*}v_{05}{}^{i1}} = 1$$

$$B \gtreqless A = 1,$$

where

${}^*x_{05}{}^1$ output of product 1 at point E_5 with the improved technology and

${}^*v_{05}{}^{i1}$ input of factor i used to produce product 1 at point E_5 with the improved technology.

This conclusion holds if the technological change transforms the isoquants in such a way that the isoquant tangent to the L_0L_0 price line passing through E_1 under the new technological regime represents a higher output than the isoquant tangent to L_1L_1 at E_1 represents under this same technological regime. That is, output at E_4 exceeds output at E_1. This would be the case as long as the isoquants created by the improved technology are convex to the origin.

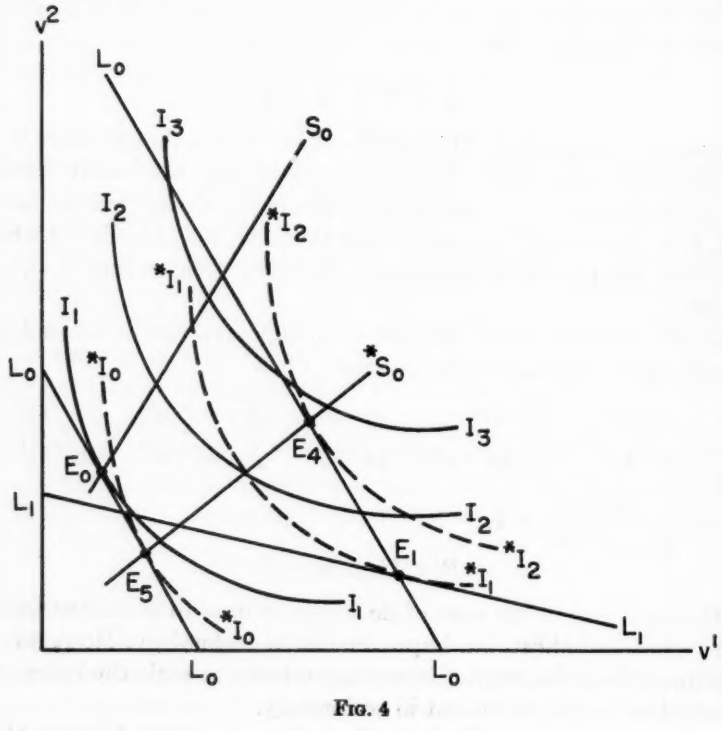

FIG. 4

Setting A greater than, or less than, one would correspond to functions of degree greater than one and less than one, respectively. It can be seen that in these two situations as well the, index of technology need not increase even though technology improves. These same conclusions hold when technological improvement occurs between the given period and the base period.

Relative product-price changes

The situation with changing technology coincident with changing relative product prices is simpler to analyze than the situation with changing relative factor prices coincident with changing technology. In fact, the conclusion with respect to the bias resulting from changes in relative product prices does not depend upon fixed technological conditions but only upon the usual assumptions regarding product transformation curves, that is, negative first and second derivatives of the relation between any pair of products.

We can conclude that in cases of changing technology and different base periods, if the index would be less than one with constant relative product prices, it would still be less than one when they did change. If it would otherwise be greater than one, changing product prices may increase or decrease its excess over unity.

VI. *Summary*

The preceding analysis concluded that the index of the physical volume of imputs is biased upward due to relative price changes. Under conditions of constant technology and changed price structures the technological index is biased downward and can equal unity only when the production function is homogeneous of degree greater than one. This index need not exceed one even when technology does improve.

A substantial amount of work has been done to apply theoretical criteria to the evaluation of cost-of-living indexes.[8] Little has been done to apply theoretical criteria to indexes of physical volume or indexes of technology; however, Simpson has made a useful contribution.[9] He analyzes Paasche and Laspeyres production indexes and concludes that in certain cases their geometric mean will give a better approximation than either one of them.

Perhaps we can come no nearer to true indexes of inputs, outputs and technology than we have come to a true index of the cost of living. However, it is certainly desirable that we be aware of the weaknesses of our indexes and that we do what is possible to increase their validity.

[8] See Melville J. Ulmer, "On the Economic Theory of Cost-of-living Indexes," *Journal of the American Statistical Association*, Vol. 41, December, 1946, pp. 530–42 and references cited there. Also see the list of references in Paul B. Simpson, "Transformation Functions in the Theory of Production Indexes," *Journal of the American Statistical Association*, Vol. 46, June, 1951, pp. 225–32.

[9] *Ibid.*

ALLOCATION OF RESOURCES IN FARM MANAGEMENT AND PRODUCTION ECONOMICS RESEARCH[1]

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THIS paper is concerned with the kind, quality and rate of production in farm management and production economics research.[2] The question of what is being done relative to what can (or could) be done with research resources provides the focal point. In order to examine this question it is necessary (1) to consider a framework or criterion for judging the relevance of research results, (2) to compare what is being done relative to alternatives, and (3) to seek the basis for the past and present patterns of allocation of research resources. We are not concerned with the question "are farm management and production economics research funds productive." Rather the relevant question is "can these research resources be made more productive."[3] We believe that research resources have often been committed with little attention being given to a fundamental consideration of basic goals and possibilities of production economics–farm management research, particularly in choosing among alternative research opportunities. The allocation of research resources is a "real world" economic problem that should be of interest to research economists and administrators. This paper is a modest effort to open this area for discussion.

In managing their businesses (formulating and evaluating alternatives, making and executing decisions) farmers are beset by many problems affecting their efforts to maximize certain economic, social and individual goals. Society also faces important decisions relating to the use of re-

[1] The basic ideas in this paper were first presented as a part of the program devoted to Research Methodology at a meeting of the Southern Farm Management Research Committee in March, 1955. The present paper reflects many suggestions and comments made by the committee at that time. We are also indebted to our colleagues at Oklahoma A. & M. College and Louisiana State University for helpful comments.

[2] Production economics and farm management are not considered to be synonymous terms. They overlap each other but each includes areas not encompassed by the other.

[3] The manner in which research results are presented to professional agricultural workers and farmers affects the real productivity of researchers since research results are not productive until they are utilized. However, questions relative to presentation, dissemination, and adoption of results will not be considered in the present paper. It is generally agreed that research in farm management and production economics is presently making a very material contribution to the welfare of individual farmers and to society. However, we are content to leave this evaluation to others. For a recent consideration of the present state of the profession see L. L. Boger, "Important Professional Problems," *Journal of Farm Economics*, Vol. XXXVI, No. 2, May, 1954.

sources in agriculture. It is the function and responsibility of research to provide information needed to facilitate the making and execution of decisions for the efficient use of agricultural resources. Thus the value of research results must be measured by their contribution to the efficiency of decision making on the part of individuals and society. Regardless of the goal of the individual or society (money income or some combination of monetary and nonmonetary remuneration), two basic types of information are necessary. These are (1) principles that effectively organize facts into a form that facilitates decision making and (2) the facts, relationships, or data needed to apply the relevant principles. Since research resources are limited, each piece of research is subject to an opportunity cost and not all "profitable" research can be undertaken. Research workers and administrators must therefore carefully consider the manner in which their scarce research resources are allocated.

The Relevance of Research Results

In order to specify an optimum research "product" the "possibilities surface" (i.e. what is possible with given resources) and the relative values of different types and combinations of research "products," must be known.[4] However, it has been suggested that there can be no objective means of evaluating prospective research projects due to the uncertainty of results.[5] It is true that one can never know with certainty the value of the product to be expected from a given proposed research program or project. On the other hand, if problems are selected in some purely subjective or random manner gross misallocations of research efforts are likely to occur.

Perhaps it is presently impossible to attach an accurate absolute dollar value to either proposed or completed research programs or projects.[6] Nevertheless, it may be possible to estimate the relative value of alternative projects assuming the objective of the research are accomplished.

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[4] We shall assume that in a competitive economy relatively free from the effects of political expediency, individual and social goals can be made compatible. The validity of this assumption and a discussion of the objectives and methods of farm management research are in Earl O. Heady, "Elementary Models in Farm Production Economics Research," *Journal of Farm Economics*, Vol. XXX, No. 2, May, 1948.

[5] W. W. McPherson, "Goals and Character of Farm Management Research," In *Farm Management Analysis; Character of the Objectives, Scope and Logic*, Southern Farm Management Research Committee, March 1954.

[6] However, it may be argued that, in most instances, research in farm management and in agricultural economics is not innovative in nature. Rather it is the bringing together of *known* relationships into a framework for decision making, with given maximization-minimization goals, to evaluate the consequences of alternative decisions or choices. If this is the case, the results of research (i.e. the possible gains that may accrue) may be predicted with a considerable degree of certainty.

Furthermore, research may be of a long-run value even though the immediate results are essentially negative. Some results, if made available to other workers, may make it possible to quickly reject an apparently promising hypothesis or suggest a more productive method of approach to a problem. In fact, negative research results (i.e. failure to solve the problem) relating to a truly important problem where uncertainty (lack of knowledge) is great may in the long run be more valuable than a "positive" solution to a problem of lower priority.

It might be argued that appropriate rules for choosing projects are not known to researchers and research administrators, even if it were possible to estimate the nature of the product possibilities surface. Some of the more difficult questions involved in choosing from among possible research projects are: (1) What is the present value of results that are not immediately applicable? (2) What is the marginal return from the development of theoretical and methodological concepts as compared with the estimation of relationships? (3) What is the marginal value of very precise estimates, as compared with a larger number of less precise estimates? (4) What is the relative value of estimates of intrafarm vs. interfarm relationships?

There is at present, no satisfactory way to objectively and quantitatively evaluate these questions so that, like most problems in real life, evaluation must finally rest on some value judgment. Also, different administrators and researchers will not seek to maximize the same ends.[7] Yet, this does not rule out the desirability of the value judgment itself being based on a formal and rigorous analysis of alternatives. Perhaps the time a researcher devotes to choosing from among alternative problems and projects could be his most productive time, for one important limitation to the usefulness of research results is the importance of the problem investigated.[8]

[7] In a paper presented at the 1956 summer AFEA meetings, Heady suggests that linear programming may be used to determine the limiting coefficients and to attach a value to the relaxation of constraints so imposed. It would appear that Heady's method might well be used to evaluate the potential contribution of technical research. However, it is not clear how this procedure would be used to evaluate the potential contribution of research projects. M. A. Efroymson in G. H. Symonds, *Linear Programming: The Solution of Refining Problems* (Esso Standard Oil Company 1955), shows that game theory may be used to select among alternative experimental programs to solve a refinery problem. This paper explicitly recognizes the uncertain nature of the research product. However, in order to apply game theory to such choices it is necessary to specify (1) the cost of the research, (2) the value of the research if it proves successful (i.e. the problem is solved), (3) the probability of various degrees of success in solving the problem. As has been pointed out previously the question of evaluation of results and establishing probablities is unsolved. Until they are solved game theory would appear to offer little help.

[8] Research resources could be allocated by simply permitting individual researchers to pursue questions that interest them. Without doubt many invaluable scientific

Past and Current Research

A review of past and current research in the area of farm management production economics suggests (1) that estimates of interfarm and interindustry relationships have been considered to have little value relative to intrafarm relationships and (2) research designed to develop or test basic concepts and research methods has been allotted a low value.

Most published research in the field is concerned with intrafarm relationships. Obviously, this information is valuable and much more work in the intrafarm area will prove useful for individual farm planning. There is still need for a tremendous amount of data dealing with basically technical intrafarm relationships such as rates of transformation, substitution rates, etc. However, the usefulness of these data for planning purposes is limited (particularly relative to long-run decisions) (1) by virtual absence of reasonably reliable price expectations, (2) by an idea of likely production innovations and shifts over time and their aggregative effects on price ratios and on the possibilities surface facing the firm. Yet empirical characterization of the basic nature of even static supply functions for farm products are virtually nonexistent.

A high proportion of the published intrafarm research considers rather small segments of the total farm business and is primarily applicable to short-run operational decisions. Current efforts to isolate relatively precise fertilizer-yield functions is a specific case in point. Observation would suggest that an optimum combination of crops may often be a more crucial question than the optimum rate of fertilizer on a given crop. No doubt the lack of suitable tools has been largely responsible for researchers' preoccupation with component parts of the farm business. The development of linear programming has focused new attention on the "whole-farm" problems. Furthermore, the question of allocation of research resources between part-farm and whole-farm research is to some extent a matter of timing. Obviously questions relating to "whole-farm" resource allocation problems could be answered more accurately if our store of knowledge of "part-farm" allocations were more complete. However, it would appear that part-farm coefficients could be more useful to farmers within the context of the "total" farm organization.

There has been a considerable amount of invaluable pioneering effort devoted to the estimation of relevant ranges of certain production func-

discoveries have resulted from research so initiated. However, a vast majority of problems in farm management and production economics are of such scope as to preclude their solution by a single individual. Thus an organized approach to problems so that individual project results will add to (not duplicate) findings of other research to provide solutions to relevant problems. Certainly relevant problems are sufficiently large, numerous, and diverse to amply satisfy individual interests within some framework of conscious, organized choice of research programs and projects.

tions during recent years. However, it has not yet been shown that estimation of such intrafarm relationships is relevant when measured by the pragmatic test of economic importance in decision making. Neither has it been shown to be unimportant or trivial. Thus the question of whether or not limited resources can be more profitably utilized in rather precisely estimating ranges of a limited number of functions rather than selected points on a larger number of functions is not a settled matter. The answers depend on the economic importance (potential efficiency gains accruing to precisely optimum resource combinations) of the estimated relationships relative to the research time involved in making the estimate, of the farmer's time and resources required to apply the results, and of the relative stability (term of usefulness) of the estimates.

Basic Research Needed

To survive, publically supported agricultural research must answer questions important to farmers and society. In other words, research must be problem solving. However, we live in a dynamic world. Answers to questions of today may not answer the questions of tomorrow and it is quite likely that the best of today's research methods will not always be the most efficient. Thus, it would appear reasonable that the development of efficient research tools, concepts, and methods has some value in answering "practical" questions and should be considered in allocating our total research resources.

Relatively little work has been or is being devoted to the development or testing of decision-making models or concepts.[9] It would appear that work in this area might complement, or perhaps profitably reorient, work dealing with the estimation of essentially technical intrafarm relationships. Most farm management researchers would agree that an immediate end of their research effort is to improve farmers' decisions. Nevertheless, little is known about how, and perhaps more important why, farmers make certain decisions. If one were ordering important research needs this problem would deserve a basic position in the structure.

Perhaps it is generally believed that the relevant principles and models for decision making are known so that the estimation of the relevant models by researchers and the teaching of these principles to farmers by extension workers is all that remains. It is true that marginal analysis does provide a very useful conceptual framework. However, until we know much more about how farmers actually make decisions, the information

[9] For exceptions see Glenn L. Johnson, *Managerial Concepts for Agriculturists*, Bulletin 619, Kentucky Agricultural Experiment Station; Glenn L. Johnson and C. B. Haver, *Decision Making Principles in Farm Management*, Bulletin 543, Kentucky Agricultural Experiment Station.

they use, how risk and uncertainty enter their decisions making, and have a better idea of what farmers seek to maximize, we cannot be certain of the real usefulness of research results based on static, profit-maximizing, cost-minimizing, marginal models. A research model is most relevant if it corresponds reasonably well to the models farmers use in making decisions.

During recent years the value of economic theory in problem identification, problem definition, and the design of research has been generally recognized. However, the hanging of empirical estimates of coefficients on a textbook model is not the only "profitable" use of research funds. In fact, if our research is limited to the estimation of presently "known" models or relationships, we will do little more than scratch the surface of real problems. Research is also needed to develop new theory. Presently, for example, we need theories and research models that will guide research into the area between the relatively well developed static-firm theory and the less well developed macroanalysis. No amount of firm analysis can provide answers to product-resource adjustments in agriculture until the structure that ties agriculture to the total economy is better known.

Various references have been made to so-called "service" and "fundamental" research. Service research has come to mean relatively short-run problems, often of interest to a particular group and affecting a small area. Sometimes the "problem" has attracted interest because the economic system has "squeezed" some group. The very nature of such "service" work limits its usefulness considerably. Frequently the time and effort devoted to such questions could be more profitably allocated to the determination of general principles basic to the problem of the particular group and applicable to other similar problems and to other groups.

The emphasis on short-run "service" research is not essentially wrong. In fact there are some strong and practical arguments in favor of such research. Good long-run results are often due to the cumulative effect of sound short-run developments. Furthermore, there are many important questions that can be answered as adequately by short-term service-type research as by larger scale more exhaustive investigation. Nevertheless, the allocation of resources between short-run and long-run uses might profitably be re-examined. They are not, for example, mutually exclusive alternatives. Rather, "basic" research and "service" research may well be complementary in that the development of concepts and research procedures may greatly increase the productivity of resources devoted to service work. Service or applied research and more fundamental research are necessarily interdependent and those who desire an optimum

research product must recognize that useful service research must rest on a foundation provided by research that is more basic in nature.

Agricultural economists have been generally considered "tool users" as opposed to "tool makers." Obviously the profession benefits greatly from transfers of ideas and techniques from other disciplines. It is also true that the profession has not maximized the usefulness of developments in other fields such as mathematics, statistics, economic theory, psychology, sociology, etc. Yet past experience would suggest that it is necessary to modify these transferred tools and concepts to more nearly fit the needs of agricultural economists. Certainly the profession cannot reasonably expect these other fields to deliver the latest and best from their disciplines to agricultural economists in operationally useful form. Greater interdisciplinary cooperation provides a partial answer, but basic research into concepts and methods in agricultural economics would seem to offer possibilities of very productive work.

Reasons for Present Research Structure

Probably the uncertain nature of the product, the need and the desire to deliver tangible results (largely intrafarm technical relationships), the lack of administrative encouragement and support to explore new areas, and the personal maximization goals of agricultural economists largely explain the present pattern of research activity.[10]

Not all institutions are equally well equipped (in funds, facilities, or personnel) to attack problems on a front that has both width and depth. From a practical basis the greatest emphasis is therefore usually placed on the former. Furthermore practical experience can demonstrate that a routine question-answer period at a farmers' meeting can generate more "felt" problems in a half hour than a well organized research team can answer in years.

Generally the immediately felt problems are largely of the intrafarm variety. Thus farmers "demand" answers to such questions more frequently than to longer run problems of the aggregative nature.[11] This is partly because problems that apparently arise "within the barn yard" are better understood by farmers (and by agricultural economists) and

[10] For other suggestions see H. C. M. Case and D. B. Williams, "Research Attitudes in Farm Management," *Journal of Farm Economics*, Vol. XXXIII, No. 3, August, 1951. Also, F. L. Underwood, "Points of View in Land Economics and Farm Management Research," *Journal of Farm Economics*, Vol. XXXIII, No. 1, February, 1951.

[11] There may be some question about farmer demand for the usual economic study. An analysis of the usefulness of farm management research to farmers and to professional workers (such as farm and home development workers) would seem to offer a fertile (but volatile) research opportunity.

partly because these are questions that must be answered (acted upon) immediately. Farmers have only a short time period in which to decide how much fertilizer to use while questions such as the long-run prospects of cotton in the southeast, or even the likely price two years hence is something that does not require immediate action. It may "work itself out" in some mysterious fashion or perhaps the "government will do something." Consequently, research workers and administrators usually find it desirable to give priority to relatively short-term questions.

Because of the nature of the demand for the product involved, administrators have little incenitve to encourage, and individual workers to undertake, research that does not promise to produce immediately useful results. Thus, it is easy to gain popular support for less complex research that is "certain" to provide answers (such as the cost of producing some crop in some county in some year) as compared with research that will be helpful in solving some longer-range problem, developing more efficient research procedures, or providing more useful theory and concepts.

The Allocative Problem

Research resources are allocated primarily by two groups of individuals, namely researchers and administrators.[12] The individual researcher must consider his resources and alternatives to determine how his own efforts can best be applied. The research administrator has a no less complex problem for he must achieve a balance within his organization by combining resources of individual researchers. The individual can change his "mix" of product by his choice of projects and the administrator can change the product combination of the organization by choice of personnel and by the emphasis given to different types or areas of research.

Perhaps some individuals and organizations may best devote their resources entirely to the development of procedures and concepts while others may be more productive in service research. However, we would hypothesize (1) that research results will be more useful if more careful consideration is given the choice of research programs and projects, (2) that most individuals and most organizations can be more productive by working simultaneously on integrated service and basic research, and (3) that the value of the research product could be enhanced by relatively more attention to interfarm-interindustry analyses, methodological issues, and to the development of improved research methods.

[12] Legislation also allocates research resources. This may impose certain restrictions, but there still are problems of alternative choice for administrators and researchers.

A LINEAR PROGRAMMING MODEL FOR DEVELOPMENT OF FEED FORMULAS UNDER MILL-OPERATING CONDITIONS

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THE applicability of linear programming to the problem of determining a least-cost feed mix is well established. Waugh's pioneering article[1] presented the principles that have since been elaborated by Fisher and Schruben,[2] Swanson,[3] and most recently by Katzman.[4] Despite the convincing logic of these works, the technique is not yet commonly used in the feed industry. This failure of the technique to gain general acceptance led us to the believe that there were problems involved in its use that were not adequately treated in earlier models of the mix problem. This is not a criticism of the earlier works. Their primary purpose was not the development of operational systems, but presentation of the technique.

The earlier models were strongly oriented toward the nutritional aspects of the problem of formula development. In our discussions with mill personnel we found that operational aspects of the mix problem were also very important. Some of the operational aspects of the problem not adequately treated in previous models were: (a) provisions for bulk control and flexibility in bulk control (b) provisions for control of the level of entry of individual ingredients and flexibility in this control and (c) provision for taking into account milling-in-transit privileges. These are aspects of the problem related not to the nutritional aspects of feed mixing so much as to the operating conditions of the feed mill. To the commercial feed mixer these operating problems are as important as the question of nutritional adequacy. Since the nutritional problems are

* The authors are indebted to many persons of the Pennsylvania State University staff for assistance and encouragement in the work reported here. The contribution of Professor George E. Brandow of the Department of Agricultural Economics and Rural Sociology to the early development of this research was particularly significant. The cooperation of the Cooperative Grange League Federation Exchange, Inc. through its Mill Division was essential to this work. Mr. Fred H. Hessel, nutritionist, and Mr. J. W. Stiles, director of research, of the G.L.F. were particularly helpful.

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[1] "The Minimum-Cost Dairy Feed," *Journal of Farm Economics*, Vol. 33, Aug. 1951, pages 299-310.

[2] "Linear Programming Applied to Feed Mixing Under Different Price Conditions," *Journal of Farm Economics*, Vol. 35, Nov. 1953, pages 471-483.

[3] "Solving Minimum-Cost Feed Mix Problems," *Journal of Farm Economics*, Vol. 37 Feb. 1955, pages 135-139.

[4] "Solving Feed Problems Through Linear Programming," *Journal of Farm Economics*, Vol. 38, May 1956, pages 420-429.

treated adequately in the previously cited models, the difficulties involved in applying the technique appeared to be in dealing with the operating problems.

We began developing, some eighteen months ago, a model that would treat both the nutritional aspects and the operating aspects of the feed-mix problem. In this venture we sought and obtained the excellent cooperation of the Cooperative Grange League Federation's Mill Division of Buffalo, New York. Communication proved to be the most difficult procedural problem in this cooperation. The procedure used by the mill in developing formulas was so complex to an outsider and so much a matter of routine to the mill's personnel that mutual sensing of problem dimensions was difficult. The present model is a result of trial and error. Several previous models each failed to take adequately into account some operating problem of the mill. The present model probably is not complete for all operating situations, but it would be operational for the cooperating mill.[5]

In addition to providing a useful point of departure for anyone interested in developing a similar feed-mix model for different circumstances, we believe the model employs some techniques that may usefully be employed in the solution of problems unrelated to feed-mix formulation.

Mill Operation

As noted above the operational problems of mill management must be considered in development of feed formulas. Therefore, the basic elements of mill operation will be sketched here and the relationship of these elements to the development of a linear programming model will be demonstrated.[6]

The actual mixing process is a complex materials-handling problem. A usual arrangement is that of a series of bins from which the ingredients are fed in metered amounts on to a belt or screw conveyor. The metering devices are rather precise. Adjustment to pounds per ton presents no particular problem. This is fortunate from the standpoint of using linear programming for formula development. To adjust a linear programming

[5] We are continuing our cooperation with the mill to determine the simplest models that will adequately deal with the usual operating problems. The model we present here is much more complicated than necessary in that it attempts to exhaustively treat all operating problems that may arise.

[6] The description of mill operation presented here is based, in the main, upon the operation of the cooperating mill. Thus the description is not apt to fit precisely the operation of any other mixiing plant. The same kind of operating problems are apt to be encountered in most mixing plants, however. Another common type of mill employs a batch mixer. In this type mixer, the ingredients are weighed whereas in the continuous mixer they are volumetrically metered. The feed is mixed in batches of one to three tons in this type mill.

solution to the conventional 10-pound units requires considerable time and sacrifices cost-reducing precision.

The number of bins that feed on to a line limits the number of ingredients that can be used in a mix. The number of bins varies from plant to plant. This could be a cause for restrictions in a linear programming model except that normally some ingredients may be pre-mixed at modest cost. For instance, in a six-bin plant the capacity for ingredients could be raised to ten by mixing five ingredients and storing the mix in the sixth bin on the line and then feeding this mix out as an ingredient in subsequent mixes. In this manner the capacity of the plant for ingredients is practically unlimited.

The conveyer feeds into a mixer where the ingredients are agitated so as to thoroughly blend the materials. If liquid molasses is to be included in the feed it will be added directly into the mixer.[7] Liquid molasses is one of the few ingredients that is limited in its use by the mechanics of mixing. If too much is added, the performance of the mix line may be impaired or the mixed feed may have poor storing quality. The maximum amount that may be used depends upon the temperature and the character of the other ingredients. The relationship is, however, poorly defined so until additional research evidence is available the limit on molasses will probably be set at an arbitrary level known by experience to be safe.

From the mixer the material goes to weighing scales and from there directly to the baggers.[8] It is in this phase of the operation that the bulk or density of the mix is of critical importance. The weighing scales are designed for a particular volume that is in balance with the mix line and the bagging installation. If the feed mix is too bulky the capacity of the hoppers is exceeded. This results in a slowing down of the mix line with the result that the marginal cost of mixing the bulky material is prohibitively high. The possible saving on ingredient cost from using bulky materials probably would never justify the slowing down of the line.

At the same time, the material can be too dense for efficient operation of the bagger. As the mix departs drastically from the density the bagger was designed to handle it becomes necessary to change size of bag. If the change in density is frequent, the shifting back and forth among bag sizes destroys the routine of the operation and reduces performance. Another aspect of the bulk problem is that farmers who feed by measure prefer a feed of uniform density over time. All these factors work toward requiring that the mix conform to a fairly narrow range

[7] Some mills use a molasses blender that is separate from the mixer.

[8] This description applies to dairy feed in particular. If the feed is to be pelletized (or similarly modified) this would be done directly after mixing.

of bulk density, but variation within this range may permit considerable saving.

The bulk problem is difficult to deal with in terms of the logic of linear programming. The difficulty lies in the fact that the bulk of the final mix is not the sum of the bulk of the individual ingredients entering the mix. Thus, one of the basic assumptions underlying linear programming is violated. Some experimentation by the cooperating mill resulted in a discovery that promises to permit the use of the assumption of additivity of bulk. The primary ingredient found to be responsible for non-additivity of bulk was liquid molasses. Molasses is the most dense of common feed ingredients but due to its tackiness it aggregates particles of other ingredients so as to increase the bulk of the mix. The practical

TABLE 1. AVERAGE WEIGHT AND RANGE IN WEIGHT PER BUSHEL OF COMMON FEED INGREDIENTS*

Ingredient	Average bushel weight (pounds)	Range in bushel weight between lots	
		High (pounds)	Low (pounds)
Corn gluten feed	37	44	30
Ground oats	27.5	29	26
Corn meal	46	50	43
Hominy	40	46	30
Ground barley	41	44	38
Rice bran	30.5	36	26
Soybean oil meal	45	58	39
Corn distillers' dried grains	38	47	23
Brewers' dried grains	18	24	11
Standard middlings	27	30	26
Molasses	109	—	—
Dicalcium phosphate	85	100	66
Salt	93	98	84

*Source: Mills Division of the Cooperative Grange League Federation Exchange.

handling of this bulk problem consists of assigning an artificial bulk coefficient to molasses. A coefficient of zero bulk has given rather satisfactory results.

Each ingredient is variable from lot to lot in its characteristics—particularly with respect to bulk. The following indicated the average and range in weight for common feed ingredients received by the cooperating mill. Fortunately it is a rare instance in which all of the ingredients being mixed run at the low or the high side of the range at the same time. Thus, the extremes generally tend to cancel out to give a mix within predictable limits on bulk.

Sampling of individual car lots of ingredients for bulk is generally out of the question. The railroad cars are unloaded directly into the bins

on the line. There is no opportunity for sampling and blending to achieve uniform densities since very little material is stored by the mill.

The ideal linear programming model would be one that permits easy variation in the bulk requirement of the mix. Then a solution could be obtained for the least cost mix of artificially high bulk if the ingredients were running abnormally dense or vice versa. This variation also would permit reaching the least-cost mix within the range of bulk variation allowed by the mill.

Ingredient Procurement and Supply

The procedure for procuring ingredients is of interest in developing a linear programming model of the mixed process. Mills normally stock very little material. Ingredients are purchased on the basis of estimated need on the delivery date. The difference in time between the date of contract for purchase and the date of delivery at the mill varies greatly among ingredients. For example, corn may be purchased a few days in advance of use and molasses may be purchased on annual contract.

Total supply of ingredients consist of the amount "in yard," the amount in transit, and the amount on contract plus a relatively small amount in plant storage. The major part of supply for a given planning period for formula development, normally would be the amount due to arrive at the mill during the planning period—usually "next week." In emergency situations additional supplies of some ingredients usually can be obtained in the local market area but at contract prices that are higher than usual.

The prices used in developing feed formulas are usually the contract or current market plus any charges incident to getting the material to the plant. If these prices are used in the linear programming model, however, the solution may indicate use of some ingredients that are in short supply due to the in-transit lag. The mill generally does not favor sudden shifts in operation to capitalize on temporary market situations. The costs in terms of disturbance of well developed routine likely would outweigh the slight saving in ingredient cost. The buyers work within the framework of a well developed procurement policy. This policy is subject to change on the basis of projections well beyond the current-formula planning period. To a degree, therefore, the current supply situation is dictated by decisions made in the past. Drastic changes in price may result in current supplies being out of balance but the policy of projecting demand is necessary from an operational standpoint.

A model that takes account of this price and supply situation is possible but it would be extremely cumbersome and expensive to use. It would require several "capacity limits" for each ingredient. Fortunately this complexity is not required. Some ingredients are normally in ample supply and special provision need not be made for control of their entry.

Another group of ingredients is usually available in ample supply if they are available at all. This is easily handled by blocking entry of the ingredient when it is out of supply. For the few ingredients requiring variable control over entry due to supply, the model must provide the degree of control needed to deal with the problem realistically. Choice of degree of control becomes a compromise between precision or accuracy in determination of least cost and the size of the problem.

"Milling In Transit"

If feed ingredients are used that have "milling-in-transit" privileges the mix may move from the mill to retail outlet at a lower freight rate. Not all the material in the mix need have "in-transit" privileges in order to receive the rate advantage. As a general rule at least 60 per cent of the weight of the mix must consist of such ingredients in order for the mix to move at the lower rates. Only the weight of the "in-transit" material goes at the lower rate and only ingredients moved by rail have these rights.

The source of the ingredients, railroad tariff classification and the destination of the mix mutually determine whether an ingredient has the "in-transit" privilege. Although some back shipment may be authorized by some carriers, the usual regulation will permit the ingredient to be milled and shipped at a reduced rate only in the same general direction as the original movement. For example, corn from Chicago could be milled in Buffalo and shipped east to Albany at a reduced rate but could not be shipped back toward Chicago at the lower rate. Conversely rice bran entering the port of New York and going by rail to Buffalo enjoys lower rates going west of Buffalo but, bears full rates moving east. The farther the shipment originates from the mill the greater the potential saving on transportation. This is due to the structure of railway rates which decline as the distance increases.

With a mill in the center of its trade area and ingredient sources distributed fairly uniformly around the mill, each point of shipment would call for a particular least-cost mix. In practice the problem may approach this degree of complexity, but at present mixers do not differentiate this precisely. One single mix may be formulated which represents a compromise, or the mill may formulate one mix for "western" and another for "eastern" customers.

Taking advantage of milling-in-transit privileges is of such importance that it should be included in a linear programming model. The cooperating mill does not have this problem to the degree that other mills may since the bulk of its trade area lies to the east and its sources of ingredients are mostly in the west. Therefore, situations more complex than the cooperating mill encounters shall be considered.

Timing of Formula Changes

The development of feed formulas is a rather continuous function of certain mill personnel. The information on sales, shipments, prices and ingredient supplies come to this personnel throughout the week. Opinions are formed as to the changes that seem to be shaping up but the crucial period is the last day during which all the evidence accumulated over the past week must be weighed and a decision made on formula changes.

As far as the aspects of handling materials are concerned changing formulas is a relatively simple matter. It involves primarily the resetting of the metering devices on the feed bins. There are other changes that are not so readily made. Here it is important to distinguish between the change of an open formula and the change of feeds having a closed formula. In either case feed tags must be printed showing the ingredients contained in the feed mix. Presumably, however, the tags for closed-formula feeds could be used without change if only token quantities of the ingredients named on the tag were included. All ingredients ever to be considered for the mix in question could be printed on the tag.

With open-formula feeds the actual amount of each ingredient is shown. This necessitates a greater delay between determination of the least-cost mix and the implementation of a change than for closed-formula feeds. If printing of the tags were the only concern the delay would be minor. The purpose of making open-formula feeds is to let the farmer know exactly what he is getting. Some of the advantage is lost unless prior notice of change in formula reaches the farmer. Therefore, the mills that mix open-formula feeds distribute to their dealers a notice in advance of the change. This requires two or three days lapse of time. The cooperating mill makes the decision for change on Wednesday prior to the actual change on the following Monday. This close schedule imposes an element of timeliness into the problem of solving mix formulas by linear programming. In the cooperating mill the information on prices is not finally set until noon on Tuesday. At the maximum, the linear programming solution must be developed in one day's time. Some of the questions of supply availability may not be answered until even later in the day. This requires that the procedure for solving the problem be highly efficient. In practical terms this requires access to an electronic computer in all but the simplest cases to be considered later.

Subjective Considerations in Formula Development

Subjective elements enter into consideration of formula development in addition to the objective nutritional standards. As a nutritionist for a feed mill said of a dairy feed "We must first feed the farmer, then the cow," so it is of all feed mixes. Thus, a feed that meets all the nutritional standards yet established may be completely unacceptable. Chief among

the subjective considerations are texture, color and palatability. Not only are all of these subjectively appraised but, to further complicate the problem, probably are not additive. In the absence of better guides the cooperating mill places absolute maximum limits upon certain ingredients, to protect against unsatisfactory mixes. Wheat bran is limited to 15 per cent in dairy feed to prevent the mix from appearing "too branny." Standard middlings is limited to 15 per cent in dairy feeds to avoid unpalatability and so on. In all likelihood there is an important interaction effect between the ingredients with respect to these characteristics. For example, more than 15 per cent standard middlings probably could be used if all other ingredients were highly palatable. On the other hand, 15 per cent may be too much if other ingredients are unpalatable.

The interaction among ingredients of a mix is recognized by the mill in the case of molasses in dairy feed. Since this material is highly palatable it is included in the dairy mixes without close regard to cost. In addition to making the mix more palatable, molasses also imparts a dark color to the mix. This color is desired by the farmer if not by the cow. It also aggregates fine particles and keeps the mix from being "dusty."

Mix Standardization

In recognition of problems of palatability and appearance and the problem of bulk variations, a process of standardization of mixes is being developed. In this process the mix is pulverized to destroy the identity of the constitutent ingredients. Flavoring, coloring and perfuming materials are added to dominate the natural flavor, color and odor of the original ingredients. The material is then put through a process similar to that used in making pelletized feeds. The material is then ground to desired texture, screened to remove dusty particles and then, if desired, mixed with molasses and bagged. This, of course, requires extra equipment and extra processing and increases the cost of the feed over what it would have been had the materials been sold as an unmodified mix. On the other hand, it may enable the mill to use cheaper ingredients so that the total effect could be a reduction in cost.

This standardization would simplify the model required for linear programming. At present it is necessary to introduce mix-vector coefficients to limit or require the entry of particular ingredients. The required ingredients can be handled by calculating the mix vector taking into account the required material. A disadvantage of this is that the "requirements" are often conditional. Molasses will be put into a dairy mix at the maximum permitted by the mixing process if molasses is in good supply and if doing so will not increase the cost "unduly." Where the same model is to be used over a long period of time, it probably is best to make provision for possible variation in level.

Multiple-Formula Model

A mill customarily makes many feed formulations. Some of these formulas have about the same list of possible ingredients. For example, virtually the same list of ingredients is considered for all dairy feeds although these feeds range from 12 per cent to 40 per cent protein content. In addition the same basic requirements may hold for a large number of feeds. In terms of linear programming they require many of the same rows. In this circumstance considerable economy can be realized by introducing as many similar mixes into the same problem as possible. All of the dairy feeds for instance may be represented by vectors in the linear programming model. Of course, only one feed mix can be solved at a time. All except one of these vectors must be blocked by large negative numbers at each running of the problem. However, the economy comes in transforming the coefficients of all the mixes at each run. When a solution is obtained for one mix, the coefficients in each of the other mix vectors are consistent with the coefficients in the rest of the tableau. By systematically ordering the solutions, a minimum of calculation is required for each new mix. For instance, a solution for a 20 per cent feed is a better approximation of a solution for an 18 per cent feed than the usual beginning solution in the "Simplex" formulation which consists of the disposal processes.

Introducing several mix vectors into the problem adds to the time required to obtain a solution for any one mix. This is true because the tableau is larger by the number of columns added to represent the additional mixes. On the other hand, it is necessary to "read in" the larger tableau only once when electronic equipment is used. This will take much less time than the "read in" of one tableau for each mix even though each is slightly smaller than the one tableau containing all mixes. There is a comparable saving on "read out" if the solution tableau is to be preserved for use as suggested below. The choice between a model containing several mixes and several containing one mix each will depend upon the speed of calculation relative to the speed of "read in" and "read out." With "Pennstac," the Pennsylvania State University's computer, the advantage lies clearly with the multiple-mix model since "read in" and "read out" are slow relative to calculation speed.[9]

A Model for Dairy Feed Formulas

The model discussed here includes all of the flexible dairy feeds mixed by the cooperating mill. Only part of this model needs to be

[9] With computers of speed comparable with the IBM "650" using card input the multiple-mix model has an advantage if solution can be reached in fewer than four iterations. With computers of speed comparable with IBM "704," the single-mix model is the most efficient.

reproduced in order to summarize all the salient points in the previous discussions. The disposal processes need not be reproduced since the construction of a problem in "Simplex" format has been explained fully elsewhere.[10] Only a few of the ingredients' vectors need to be reproduced to illustrate the treatment of the varying classes of ingredients. Not all of the mix vectors are presented since some duplicate others except in magnitude of a few coefficients.

Table 2 gives only the column vectors that demonstrate unique features of the model. To simplify description, the column vectors have been lettered and the row vectors numbered. The column vectors are complete but the row vectors have only the coefficients of the column vectors being discussed.

Column vector "A" is the "Po" vector of the "Simplex" tableau. In this case it is artificial in the sense that it represents no real restriction as the customary "requirements" or "resource" vector does. The single non-zero coefficient can be thought of as "capacity" for one ton of mix.

Column vectors "B" and "C" represent two of the dairy mixes included in the model. The coefficients are described in the legend. The unit is a ton of mix except that the weight and bulk of salt and mineral supplement which are added arbitrarily have been deducted. In each of these vectors there are several "+1" coefficients. These are for the generation of capacity for artificial vectors that permit modification of characteristics of the mix. These will be discussed more fully later.

Bulk modification

Column vectors "D" and "E" are a set of two artificial vectors that permit modification of the bulk requirement. As discussed earlier, such modification is desirable in order to capitalize on the variation permitted by the mixing plant and to make adjustment in the mix should many ingredients at the same time depart from their average bulk in the same direction. There are only two non-zero coefficients in each vector. "E" uses one unit of capacity generated by the mix vector and produces 5.1 bushels per ton of "bulk." It has the effect of permitting the mix to become bulky. "D" has the opposite effect.

If the exact bulk specified in the mix vector is desired, the disposal process for row "8" and processes "D" and "E" must be blocked by a large negative "c" value.[11] The disposal process for row "9" will remove the capacity for operation of the artificial vectors generated by the mix.

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[10] For example see Charnes, Cooper and Henderson, *An Introduction to Linear Programming*, New York: John Wiley & Sons, Inc., 1953, page 10, or Earl O. Heady, "Simplified Presentation and Logical Aspects of Linear Programming Techniques," *Journal of Farm Economics*, Vol. 36, Dec. 1954. Page 1043.

[11] Ten times the largest positive "c" has given satisfactory results in blocking entry of processes.

TABLE 2. COLUMN VECTORS FROM DAIRY-FEED-MIX MODEL ILLUSTRATING MIX VECTORS, ENTRY, UNREGULATED INGREDIENT VECTORS

Row No.	Column vector legend / Row vector legend	A	B	C	D	E	F	G
		P_0	40% protein dairy mix	16% protein dairy mix	Artificial vectors for bulk variation		Corn	Urea
1	Capacity	+1	+ 1	+ 1				
2	Weight		+1840	+1960			−2000	−2000
3	Lower limit on protein		+ 800	+ 320			− 172	− 268
4	Upper limit on protein		−1000	− 358			+ 172	+ 268
5	Lower limit on fat		+ 40	+ 80			− 78	
6	Lower limit on T.D.N.			1400			−1602	
7	Upper limit on fiber		− 200	− 200			+ 40	
8	Optimum bulk (bu/T)		− 67.2	− 68.5	+5.10	−5.10	+ 43.4	+ 38.4
9	Variation in bulk		− 1	− 1	+1	+1		
10	Upper limit on urea		− 100					+2000
11	Upper limit on standard middlings		− 500	− 300				
12	Upper limit on gluten feed		−1200	− 600				
13	Upper limit on standard bran		− 500	− 300				
14	Limit on brewers' dried grains							
15	Variation in limit on brewers' dried grains		+ 1	+ 1				
16	Limit on rice bran							
17	Variation in limit on rice bran		+ 1	+ 1				
18	Limit on molasses		− 60	− 220				
19	Variation in limit on molasses		− 1	− 1				
20	Lower limit on corn distillers' dried grains							
21	Variation in limit on corn distillers' dried grains		− 1	− 1				
22	Lower limit on ground oats							
23	Variation in limit on ground oats		− 1	− 1				
24	"In-transit" control		+1200	+1200			−2000	

If a denser mix is desired the requirement can be modified in two ways: by blocking the disposal processes on both rows "8" and "9" and by blocking vector "E," vector "D" will be forced in at unit level. This will reduce the bulk requirement and the reduced bulk will be exactly met. By freeing the disposal process on row "9" and keeping the restraint on the disposal process for row "8" and on vector "E," bulk may vary between the amount specified in the mix vector and 5.1 bushel less per ton. In an analogous way, the bulk of the mix may be moved to a higher fixed level or permitted to flex upward to the higher limit.

By blocking the disposal process on row "8" and permitting disposal on "9" and on vectors "D" and "E" to operate freely, bulk may vary over a range of ± 5.1 bushels. The center of the range will be the bulk given by the active mix vectors.

By releasing all restraints on disposal processes for rows "8" and "9" and on vectors "D" and "E," bulk is free to vary from the possible low bulk permitted by the ingredients to a high of the requirement stated in the mix plus 5.1 bushels. No provision is made in the model for permitting limitless bulk. This could be arranged by adding an artificial vector with a negative coefficient in row "8" and a non-positive coefficient in row "9."

Additional control could have been obtained over bulk if desired. For

ARTIFICIAL VECTORS THAT MODIFY REQUIREMENTS AND THAT REGULATE INGREDIENT AND REGULATED INGREDIENT VECTORS

H	I	J	K	L	M	N	O	P	Q	R	S
Brewers' dried grains	Artificial vectors regulating brewers' dried grains entry			Molasses	Artificial vectors modifying molasses entry		Corn distillers' dried grains	Artificial vectors controlling corn distillers' dried grains entry			Artificial vector controlling "In-transit"
−2000				−2000			−2000				
− 480				− 60			− 520				
+ 480				+ 60			+ 520				
− 128							+ 140				
−1236				−1080			−1618				
340							+ 300				
+ 111.2							+ 52.6				
+2000	−200	−400	−600								
	− 1	− 1	− 1								
				+2000	+60	+160					
					+ 1	+ 1					
							−2000	+100	+200	+300	
								+ 1	+ 1	+ 1	
−2000							−2000				−1

instance, more artificial vectors could be introduced by giving greater range and discreteness than is now permitted. Compromises between precision and problem size limit the number in this case.

Unrestricted ingredient entry

Vector "F" is an ingredient vector upon which there is no restriction on entry due to supply or ingredient characteristics. Note that the signs of the non-zero coefficient are opposite to those of the corresponding coefficient in the mix vectors. Note also that the coefficients from row "9" through "24" are all zero. This indicates something of the cost, in terms of increased complexity of the problem, of introducing the various restraints on particular ingredients and in allowing for variation in requirements and restraints.

"Not-over-type" ingredient restriction

Vector "G" demonstrates the simplest kind of ingredient restraint. The ingredient is urea which can be used as a protein substitute to a limited extent. Above a definite limit the material may be harmful so no provision for possible upward variation in the limit is justified. The capacity for urea is entered in row "10" of the mix vectors. The "16 per cent dairy mix" permits no urea. Thus its coefficient is zero. If the disposal process

for this row is free to operate, either it or process "G" can satisfy the mix "requirement" for urea. This means that the least-cost mix may have up to but not over the specified amount of urea. If the disposal process for row "10" is blocked, by a large negative "c" value process "G" must enter at a level sufficient to satisfy the "requirement" of the mix. In this case urea will be put into the mix at exactly the level specified regardless of cost. This procedure of blocking the row disposal probably will never be used in the case of urea.

The column vectors are not shown but row vectors "11," "12" and "13" specify upper limits on standard middlings, gluten feed, and standard bran respectively. These limits are for purpose of quality control and are not related to problems of ingredient supply. The column vectors for each of these ingredients will have a "limit-using" entry in the appropriate row comparable with the case of "urea." The negative sign on the non-zero coefficient in the mix vectors indicates that these are maximum limits.

Erratic ingredient supply

Brewers' dried grains are in erratic supply depending upon the activity in the brewing industry and the success of the buyers in getting a purchase contract. This situation is provided for by rows "14" and "15" and artificial column vectors "I," "J" and "K." The mix vectors have an entry in row "15" generating capacity for the operating of the artificial vectors "I," "J" and "K." Vectors "I," "J" and "K" generate respectively 200, 400 and 600 pounds of capacity for entry of brewers' dried grains per ton of mix.[12] These three processes plus the disposal processes for the rows "14" and "15" provide the degrees of control with the indicated manipulation of "c" values for the vectors:

Control of Entry	"c" Values For:*					
	Col. "H"	Row "14" disposal	Row "15" disposal	Col. "I"	Col. "J"	Col. "K"
No entry	−M	0	0	0	0	0
No control over entry	Actual price	0	0	0	0	0
Exactly 200#/T	Actual price	−M	−M	0	−M	−M
Exactly 400#/T	Actual price	−M	−M	−M	0	−M
Exactly 600#/T	Actual price	−M	−M	−M	−M	0
Not over 200#/T	Actual price	0	−M	0	−M	−M
Not over 400#/T	Actual price	0	−M	−M	0	−M
Not over 600#/T	Actual price	0	−M	−M	−M	0

* A "c" value of "−M" indicates a negative value sufficiently large to prevent entry of the vector.

[12] The mix will always enter at unit level or one ton of final mix.

Additional control could be obtained by increasing the number of artificial vectors.

Uncertain ingredients supply with preferred upper limit

Rice bran is in a supply situation comparable to brewers' dried grain except that from the standpoint of quality there is a preference for fairly low levels since heavy use may lead to palatability problems. This is less important in the concentrates than in the straight feeds. Exactly the same type of control can be used with rice bran as was used with brewers' grains since the limits can be expressed in terms of "not over" the quantity specified in the artificial vector.

Maximum upper limit upon ingredient with downward flexing

Molasses is in general desired to the limit permitted by the mechanics of mixing. However, this desire is tempered by cost. The type of control needed in this case is for an upper limit which cannot be exceeded and fixed lower limits that may be imposed as substitutes for the desired upper limit. In this case the desired level is entered in the mix vector and artificial vectors are put into the model to permit lowering the limit. By introducing the desired level in the mix vector it is possible to gain a point of control that was not possible in the cases represented by brewers' dried grains. A disadvantage of the type of control used on molasses is that it is not possible to remove all restrictions on use. This is not a shortcoming with molasses but could be with other ingredients such as brewers' dried grains.

The least-cost mix having molasses at the level specified in the mix vector can be obtained by solving with column vectors "M" and "N" and disposal process for row "18" blocked by large negative "c" values. The disposal process on row "19" enters to deal with the capacity for "M" or "N" generated by the mix vector. Any level up to that specified in the mix vector would be obtained by blocking column vectors "M" and "N" and leaving the disposal process on row "18" free to operate.

The level can be reduced by blocking entry of the disposal process of row "19" and one of the two (for the more general case all except one) artificial vectors modifying molasses entry. In the case of the "16 per cent protein dairy mix," column vector "C," the mix vector calls for 220 pounds of molasses per ton. If artificial vector "M" is forced in, the maximum level is 160 pounds, if vector "N" is forced in, the maximum level becomes 60 pounds per ton. These lower levels may be made exact requirements or permissive maxima. Manipulation of the disposal processes as outlined above will give these different meanings.

Desired minimum ingredient limit with downward flexing

Another class of ingredients, represented by corn distillers' dried grains and ground oats, are desired in minimum amounts but with a view to cost. The type of control over entry in this case is somewhat different from the simple limited supply situation represented by brewers' dried grains.

In this case, the mix vector does not specify the level desired but generates capacity for artificial vectors. Choice among the artificial vectors permits specifying "at least" the amounts indicated by the artificial vectors. These "at least" limits can be converted into exact requirements if desired by blocking the disposal process for the row indicating ingredient capacity. The artificial vectors "P," "Q" and "R" permit setting the lower limit on corn distillers' dried grains at 100, 200 or 300 pounds per ton.

"In-Transit" Ingredients

The advantage of using "in-transit" ingredients was presented earlier. A model permitting full expression of this problem in its most complicated form would require dual entry of all ingredients. One vector would represent the ingredient with and the other the same ingredient without "in-transit" privileges. The least-cost mix for each shipping point could then be formulated by permitting whichever of the pair of vectors for each ingredient was appropriate to enter the mix. Or if an ingredient were available from two sources, one with and one without transit privileges, both vectors could be permitted to enter and the difference in price to be reflected in their "c" values. The "c" values could also be adjusted to reflect the saving in transportation to the destination of the ingredient from the "in-transit" source.

Fortunately the problem will seldom be this complex. Some ingredients will have no "in-transit privileges. For example, ingredients arriving exclusively by truck or by barge would be in this category. On others the point of origin of rail shipment would be so close at hand that potential savings would be trivial. In the case of another group of ingredients, all sources of the materials will permit "in-transit" milling for all shipping points of the mix. For each mill the situation will be different but the model is flexible enough to deal with most of the possible situations.

The coefficient in the mix vectors on row "24" indicate the pounds of "in-transit" ingredients "required" to realize "in-transit" rates—in this case 1,200 pounds. All "in-transit" ingredients have—2,000 on this row and all other ingredients have zero. The disposal process for row "24" will permit the "requirement" to be exceeded. A supply situation may develop where it would be less costly to pay the added freight and mix less than the minimum from "in-transit" ingredients. Artificial column

vector "S" was introduced to cover this situation. Normally vector "S" would be blocked with a large negative "c" value but would be freed to operate when the question of sacrificing the "in-transit" privilege needs to be answered. When this test is made the disposal process on row "24" must be blocked or a meaningless solution will be obtained. The "c" value for "in-transit" ingredient vectors must be changed to remove the saving on transportation since none would be realized unless the minimum level were met.

The coefficients in row "24" of the ingredient vectors in Table 2 indicate that corn, brewers' dried grains, and corn distillers' dried grains have "in-transit" privileges for the shipping point of the mix being formulated while urea and molasses do not. For the sake of brevity, none of the dual ingredient vectors are shown. Corn purchased locally would be represented, for example, by a separate column vector exactly like the one shown except for a zero coefficient in row "24."

Number of Ingredients

One possible problem known to exist is not included in the model. This relates to the desired number of ingredients in the mix. The maximum number of ingredients that can enter a solution using the model outlined is sixteen. The minimum number that can enter and still give a solution varies among mixes and depends on whether or not the minimum requirement of specified ingredients is imposed. Presumably four ingredients could meet the requirements of a closed-formula dairy feed produced by the cooperating mill.

It is not likely that a solution will range to either of these possible limits. Even if this did occur, the solution might be acceptable by the subjective standards the mill personnel would apply. Thus, inclusion of a procedure for controlling the number of ingredients did not appear justified. A consideration in this decision was the difficulty of obtaining the desired control.

The number of ingredients cannot be entered directly into the problem as can most other characteristics. The possible number can be increased by adding requirements of a trivial sort. For example, requirements could be entered for calories, net energy and digestible protein in the dairy-feed model presented in Table 2. If these requirements are set at levels that would normally be met anyway, they can be exactly met with slight increases in cost. On the other hand, the number of possible ingredients entering the mix can be reduced by eliminating requirements. For example, fiber or upper limit on protein could be removed from the model without serious difficulty. Another possible upper limit on ingredient number can be obtained simply by restricting

the number of ingredients permitted to enter. A solution routine could be developed whereby the computer would select the least-cost mix having no more than a prescribed number of ingredients. The prescribed number could be chosen arbitrarily up to the limit of the model and down to minimum number that possibly could meet the requirements. The problem of number of ingredients did not seem important enough to justify its treatment in the model.

Permanence of Model

In the linear programming model the "c" values do not enter directly into the transformation of the coefficients—excluding the "z-c" coefficients. At any point in the solution of a problem a "c" value may be changed and the solution procedure continued. If the change is significant the solution will require more calculation than if the change had not been made but perhaps not as many calculations as would be made if the problem were begun anew at the point of change.

This characteristic of the solution process can be used to advantage in the feed-mix problem. Instead of beginning the problem from the conventional "first tableau" the problem may be begun with the tableau representing the solution to a previous problem. In operational terms, the problem for "this week" will begin with the tableau solution for "last week" with the appropriate changes in the "c" values.

It is possible in this way to avoid some runs on the computer by doing a few computations on a desk calculator. If, for instance, there were only one or two price changes since "last week" anl all supply conditions remained substantially the same, the "z-c" values could be easily computed for the vectors having the change. It is possible that the new "z-c" will remain positive indicating that "last week's" mix is still least cost. Or the new "z-c" may be a relatively small negative indicating that "last week's" mix can be improved only slightly, perhaps so slightly that expense of a new solution is not justified.

It appears feasible to use this technique in extending the usefulness of solutions to the farm level. A much simpler model could be developed for a mix problem on a farm having a few home-grown grains and mixing only a few rations. An approximate solution could be developed using average prices for a farming area within which prices are fairly uniform. The final solution could be worked out in a relatively few steps by applying particular farm prices for the items that vary from the area average.

Summary

The linear programming model presented here takes into account the relevant mill-operating problems of feed mixers in formulating nutrition-

ally adequate feed formulas. The inclusion of some of the mill-operating problems was necessary to obtain a truly least-cost formula from the standpoint of the commercial mixer. Not all of the operating problems considered in this model are apt to be encountered by a single mill at a particular point of time. Therefore, simpler models dealing with the problems relevant to a particular mill at a particular time are possible and may be developed from the model presented.

In order to overcome certain operating problems it was necessary to impose external non-price controls upon the "least-cost" mix solutions. These controls will permit the mixer to do the following:

1. Specify the maximum relative amount or the exact relative amount of an ingredient that may enter a mix. (This control is needed to meet problems in ingredient supply and quality.)
2. Change from one maximum or exact relative amount to a higher or lower level. (This is needed to meet changes in ingredient supply.)
3. Specify the minimum or exact relative amount of an ingredient. (This is needed for quality control.)
4. Change from one minimum or exact relative amount to a higher or lower level. (This is needed to permit variation in quality of mix, as reflected by particular ingredient content, with change in cost and supply of the ingredient and to determine the cost consequences of raising or lowering the minimum level.)
5. Change the bulk requirement of the mix.
6. Permit a range in bulk of the mix.
7. Change the range permitted in bulk of the mix. (These controls over bulk are needed to meet variation in bulk of ingredients and to realize cost-reducing advantages of permissible variation in bulk of mix.)
8. Test for advantage in exercising 'in-transit" privileges and specify that mix satisfy 'in-transit" conditions if privilege is to be exercised.

A means of controlling ingredient number was outlined but was not included in the model. Precision of control over ingredient number could not be achieved by a method simple enough to be operational.

The model presented is beyond solution in reasonable time with desk calculators. It is doubtful whether a realistic model simple enough for full solution on a desk calculator can be developed. Modifications by use of desk calculators of solutions obtained previously on electronic computers do appear feasible. The full model outlined in this report approaches the practical limit of capacity of the smaller commercial models of electronic computers.

ADAPTATION OF EXTENSION EDUCATION AND AUXILIARY AIDS TO THE BASIC ECONOMIC PROBLEM OF AGRICULTURE*

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PUBLIC investment in research and education for agriculture has been one of the most efficient programs directed towards the industry. This socialization of an activity, particularly research which normally is the domain of private firms, is well accepted and should continue with increased vigor. Solution of problems characterizing agriculture in a growing economy is more likely to come about through the educational system of land grant colleges than through price and production policies in sight, even if these policies could be separated from politics. Education and information, with the right focus to farm people, could be the effective force in meshing agricultural adjustments to economic growth.

Public investment in education should be looked upon as the major element of policy in the decades ahead. Permanent reallocations of labor resources between agriculture and other industries, the basic economic adjustment required in a wealthy economy subject to further growth, and shifts of production patterns for resources remaining in agriculture in line with income elasticities, must be brought about mainly by improved information to farm people, particularly youth and the more flexible or mobile portion of the labor force. Public policies are needed for lessening the instability problems unique to agriculture and for increasing the flow of capital in localities where its supply is short for farm adjustments. However, the educational element of policy, based on research to guide it and perhaps coupled with some monetary subsidies to increase labor mobility, can be the influential force in shaping agriculture to economic growth.

Past Emphasis

Although the land grant system has covered a wide range of activities, the central focus has been on providing expectations of biological and the physical coefficients. At the outset of the first century of the land grant college system this focus was correct. Knowledge of physical production potential was limited in regions barely beyond the exploratory stage and the nation's status in the ladder of economic growth called for improvement in agricultural techniques. Income per consumer was relatively low at this time and income elasticities of demand were sufficiently high

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to allow consistency between an increased agricultural output and a greater income for the same or a larger farm population. With a relatively small industrial product and labor force, minimization of labor inputs in agriculture was important to allow for growth in nonfarm products and services. During the first half century of the land grant college system, an emphasis on technical improvement in agriculture simultaneously improved the specific lot of farmers and facilitated national economic growth. Aside from war and similar exogeneous demand sources, however, this condition has not prevailed for the last three decades. A continuous focus of land grant colleges on improving technology can no longer augment farm income and at the same time facilitate economic growth. National income is now too great and the income elasticity of demand for food in aggregate is too low to allow material increases in farm income through a greater physical output over the next two decades. Price elasticities of demand are too low to allow short-run gains to the mass of farmers. The consumer, with his income increasing relatively fact, is saying, through the penalities that he attaches to farm prices and incomes, that he wants less food relative to other products and that he wishes some resources transferred from agriculture to other industries.

This framework is today's challenge for the educational activities of the land grant college system: to bring about adjustments in agriculture that are consistent with and called for by a growing economy. The relevant goal is no longer that of emphasizing biological and physical techniques in agriculture, but of emphasizing the interrelationships of agriculture with the rest of the economy. To be certain, investment in extending new techniques needs to be continued and extended, but more in terms of total economic growth than in increasing the incomes of farmers per se. But at the same time, the relative emphasis of educational services should be shifted to facilitate agricultural adjustments in line with national economic growth.

In the remainder of this paper, we (1) outline some of the alternative ends to which the educational activities of land grant colleges might be devoted (2) examine the consistency of alternative means with possible goals, and (3) specify some of the directions that might be followed in education if maximum contribution is to be made to economic growth.

Alternative Goals

Several alternative goals could be selected as the focus of educational activities in land grant colleges. The goal selected largely specifies the means. The means are reflected in the types of information carried to farm people, the types of specialist (animal husbandrymen, agronomists, economists, vocational guidance specialists, etc.) who are em-

ployed by the Extension Service, the relative amount of funds used in low-income counties as compared to high-income counties, the methods employed in contacting people and communicating ideas, etc. Means or educational patterns selected can be either consistent or inconsistent with the end held. We believe that currently, conflicts do exist between (1) major ends or goals which educational administrators use as the allocative focus of their program, (2) the means employed and (3) the actual ends attained. Accordingly, we outline a few of the more relevant ends to which educational, particularly extension, programs might be directed and examine the consistency of alternative means.

Increasing the total income of farmers

Perhaps the most widely held goal of extension education is to increase the aggregate income of farming. If this goal were the relevant one, the direction of education activity and employment of specialists would be quite clear. Specialists would not be employed and information would not be communicated to increase output where the price elasticity of demand is less than 1.0. The reason is obvious: this activity, if applied to mass groups of farmers, causes income to decline because it brings about a percentage reduction in price greater than the percentage increase in output. Unfortunately, the list of commodities with demand elasticities greater than 1.0, those where an increase in output will cause an increase in total revenue because the percentage reduction in price is less than the percentage reduction in output, is very small. Hence, if the goal of extension activities were actually that of increasing farm income, and not necessarily that of maximizing the welfare of farm people, specialists would not be employed and information would not be extended for techniques that increase output of such commodities as wheat, corn, potatoes, hogs, many dairy products, peanuts, cotton, poultry and most other common farm products. Specialists could be used for techniques that increase output for the small list of commodities that do have price elasticities of demand greater than 1.0. More nearly, physical specialists would be those with engineering emphasis, to assist in techniques that lower costs per unit but do not increase output. Biological specialists would not fit into this scheme so well, for although biological techniques lower costs per unit, they also generally increase output. Even an engineering innovation that has first impact in reducing total costs may lower marginal costs to an extent that output finally does increase.[1]

[1] Numerous modifications could be added, such as output-increasing techniques where total cost is reduced more than total revenue. For detail on added points such as these, see Earl O. Heady, "Basic Economic and Welfare Aspects of Technological Advance," *Journal of Farm Economics*, Vol. 31, 1949.

Our point is that many of the activities now emphasized in education are not consistent with increasing gross revenue of agriculture.[2] If greater revenue to agriculture were the sole end of extension activities, the means employed are highly inconsistent with the goal. We do not infer that specialists in most types of technological improvement should be dropped from extension programs. In fact, as we bring out below, this type of activity is consistent with other possible and important goals of extension activity, if other means are employed with it. However, it is generally inconsistent with the goal of increasing farm income. If this were to be the actual goal of extension education, emphasis should be on experts who would help farmers form monopolies and reduce output, at least to the point where price elasticity of demand becomes 1.0.

Maximizing the welfare of farm people

Welfare of people in agriculture might be increased by any educational activity that extends output where price elasticities are greater than 1.0 or lowers total costs but does not increase output for commodities with inelastic demands. However, welfare also can be increased by extending output for commodities with inelastic demands, as long as the reduced total revenue is redistributed so that the increase in utility to farm families realizing a gain is greater than the reduction to those realizing a loss. Suppose, for example, that output increases by 10 percent from a new technique while price declines by 15 percent. Although total revenue will decline, revenue will increase for farmers whose output increases by 20 percent, but decline for those whose output increases by only 5 percent. Of course, the difficulty of interpersonal utility comparison prevents any easy designation of which group of farm families might gain in utility relative to the loss of others. However, this problem exists even though there are no formal programs in extension education to benefit one group at the expense of the other. Indeed, the activities in extension education do cause redistribution of income and assets. Historically, the effects of education in causing income to be redistributed have been more in the direction of farm families who have the highest income. This tends to be true because these are the operators with the capital for investment and for taking risks in new techniques and they are easiest to contact. Interpersonal utility comparisons are difficult in any case, but it is more likely that total utility of the farm population is increased by shifting a given increment of revenue from high-income farmers to low-income farmers than vice versa. Even then, compensation of some form, a practice not fol-

[2] Of course it is true that even though demand is inelastic, a few farmers who first adopt an output-increasing technique, and who do not produce enough to affect market prices, can gain from any type regardless of the demand elasticity. However, the emphasis of this paper is on macro adjustments and mass farmer reaction.

lowed even with the historic pattern of continuous redistribution towards high-income farms, would be necessary to guarantee an increase in total welfare. If there are any clear directions for increasing total welfare through farm techniques alone, education should emphasize low-income farms. Given this goal, one of the means can be specialists in commodities with low price elasticities of demands; but the means necessarily must emphasize use of educational resources to increase the output of low-income relative to high-income families. In other words, a relatively greater educational input must be used in counties where incomes are low; relatively more emphasis must be placed on low-income farmers in any county. This is in contrast to the general pattern where states and counties that have farmers with the highest income also have the largest number of extension specialists and county personnel.

The goal selected as the relevant framework for extension education not only provides the basis for determining the allocation of educational resources among (a) fields of subject matter specialization and (b) geographic and income strata of farmers, but also in specifying the communication methods employed. If the goal were mainly one of "providing educational services to those best equipped to acquire them" (usually farmers with ample capital and education), then communication methods could include only meetings at state colleges, television programs and technical bulletins. The consumers would have time, foresight and funds for coming after the information. However, if the goal is one of maximizing welfare of farmers, with emphasis on increasing utility of farm families who have low income, the communication system needs to be quite different. Perhaps it cannot be in terms of mass media. The low-income farmer may not have the funds for a television set or a trip to the state college meeting; he may not be able to understand a highly technical bulletin. The communication method more nearly needs to be one of "taking the educational input to the farm."

Consideration of education as a resource also helps in understanding why these free inputs are not claimed by a large number of low-income farmers. Suppose we consider another resource, such as hog feed, which is free but cannot be resold. What limits the amount of this free resource claimed by individual farmers? The answer lies partly in the technical complementarity between the free resource and other resources possessed by the farmer. Obviously, he would not drive to the county agent's office and claim the free bags of hog feed if he had no hogs; he would claim only a few bags if the herd to be fed were small; he would claim many bags of free feed if he had many hogs, if the resource could not be resold in the market. The situation is familiar for education as a free resource. The farmers who claim or use large amounts of this free

resource are those who have large amounts of the complementary resource to go with it. The complementary resource is mainly capital. When two resources are pure technical complements, there is no logical reason for using more of one than is consistent with the amount possessed of the other.

The extreme situation of complementarity is that illustrated in Figure 1 where the isoquants form a right angle. Here, if the capital possessed is only OC_1, there is no reason to use more than OE_1 of educational inputs: output cannot be increased or capital cannot be replaced by using more informational inputs. If, however, capital possessed is OC_2, the amount of free educational inputs which should be claimed and used is OE_2. Actually, educational and capital resources do serve as substitutes over small ranges, as illustrated in Figure 2 where the isoquants have a negative slope over a small range. Here, where education is free, it pays to substitute this resource for capital; as long as the substitution ratio is greater than zero. However, it never pays, for a given output, to push educational inputs beyond the ridgeline (isocline of zero substitution rates) OL, even though education is free. Hence, a farmer with only OC_3 of capital has no logical reason for claiming more than OE_3 of educational inputs. However, an operator with OC_4 of capital might justifiably use the larger amount of educational inputs, OE_4. In other words, an educational program that employs the proper

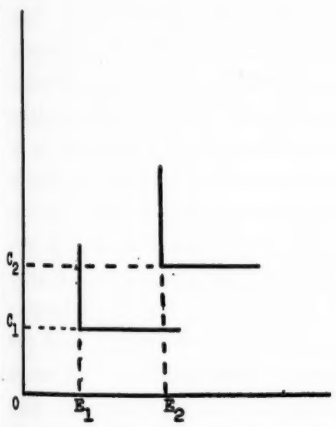

FIG. 1

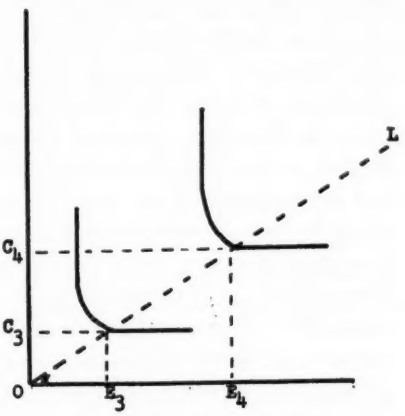

FIG. 2

ISOQUANT MAPS SHOWING POSSIBLE COMBINATIONS OF CAPITAL AND EDUCATIONAL RESOURCES IN PRODUCING GIVEN OUTPUT LEVELS.

means for attaining the goal of increasing revenue and welfare of low-income farmers needs a complementary means to go with it: a program

furnishing capital which is a technical complement to, and provides a limit in, effective use of education.

Promotion of national economic growth

A final alternative goal considered in this paper and one that might serve as the focus of an educational program is promotion of national economic growth. The focus under this goal would be information (1) to free a maximum of resources from agricultural production in order that they are available for producing the other goods upon which a wealthy society places a premium and (2) to facilitate the movement of these resources from farm to nonfarm activities. One characteristic of a wealthy society is the smallness of the labor force required in agriculture. Food can be looked upon partly as a subsistence good, the requirements of which must be met before the broader vista of consumption is open to individuals. Hence, the fewer the resources required to produce the agriculture product, the greater the quantity that is available for producing the nonsubsistence goods desired by the consumer. Although not all farm products fall in the subsistence category and the above statement applies to some degree to all desired products, the current outcome of educational services by land grant colleges probably qualifies under this over-all goal more nearly than for the alternative goals mentioned above. The "dramatic story of agriculture" in the last few decades has been in reduction of labor requirements and inputs; from a point where one person produced the food product for three others, to the point where he now produces the food for 20 other persons. An important difference in the production potential and living standard of Russia and the United States is that roughly 50 percent of the labor force in Russia is required in agriculture while only 10 percent is required in the United States. Another indication of the success in lessening agricultural labor requirements are depressed prices and incomes of agriculture. Consumers are saying that too much labor is being used in agriculture and their preference is to transfer labor to other sectors. This picture will continue as the national income grows. Low income-elasticities of demand for farm products provide forewarning that consumers, as their disposable income increases with national economic growth, will continue to place a small premium on farm products. They will continue expenditure patterns in which agricultural purchases will represent a declining proportion of the total. With an income elasticity of demand for food in physical quantity of about zero, increases in the physical volume of agricultural product need only parallel the increase in population. These trends, or rapid declines in the labor required for agriculture, and a growing amount freed from this industry to allow

extended growth of the economy generally, are the important foundation upon which extension education can be based. Undoubtedly, this, rather than increasing the total revenue of agriculture, is the aggregative outcome even of current extension education. The empirical evidence lies in the depression of farm income relative to other economic sectors, the low price elasticities of demand for farm products and the current surplus of people in agriculture.

If adjustment to general economic growth is recognized as the central end or goal of extension education, the means for accomplishment can be various. Investment can be made in specialists to promote techniques for products with inelastic demands. With minimization of resource inputs for subsistence goods being a subgoal, the "lowness" of the price elasticity might be one relevant goal for allocation of resources to products and extension specialists. Educational resources need not be allocated to conform with any income distribution pattern or framework of communication media; but should be used where their marginal productivity is greatest in increasing the output per unit of those resources that are mobile and can be used elsewhere in the economy. However, an important means, complementary with those means directed towards minimizing the amount of labor used in producing subsistence food products, is that of facilitating the movement of labor from agriculture, once it has been "freed." To free labor from agriculture and then leave it stranded is as inconsistent with economic growth as in not having freed it in the first place. Furthermore, removal of the income depression for persons who are to remain in agriculture will best be brought about by aiding the transfer of surplus labor resources from agriculture. Sufficient economies to scale exist in agriculture so that fewer and larger family farms can produce with costs to allow favorable incomes at the lower prices that consumers are willing to pay for farm products. Even where returns to scale are constant, fewer farms and a larger volume per unit can result in favorable income, if costs are sufficiently less than prices. The final criterion, of course, is an amount of resources in agriculture that approximates marginal value products equal with other industries.

Information to Increase Labor Mobility as an Essential Activity of Extension Education

The macro effect of extension education, with greatest emphasis on improved technology for products with inelastic demands, is to free resources for general economic growth, rather than to increase total agricultural revenue. Investment in techniques should be continued, but the real purpose should be recognized. With recognition of the actual outcome, the essential extension activity is in providing information that

will increase labor mobility and facilitate the transfer of the surplus labor, created in large part by land grant colleges, to nonfarm employment. Proper information and education cannot alone effect this transfer, but it can be the important catalyst in bringing about the adjustments required in a rapidly growing economy. Hence, we outline some of the needed steps in agricultural education, in relation to other public services that appear desirable for the same purposes. To help labor being crowded out of agriculture to transfer elsewhere is the very minimum compensation that should be provided for farm people, if maintenance or an increase in total welfare is to be guaranteed.

The important educational need, as part of the Extension Service's challenge in and contribution to economic growth, is in providing knowledge that guides farm people to their most promising alternative in life. This activity, to the extent that it exists, is now submerged by the flow of technical information. It needs to be made a main focus of educational activities and can become the foundation stone of agricultural policy designed to solve income problems stemming (1) from both economic growth and a relative depression of farm prices and (2) from a paucity of resources and true poverty of farm families.

Vocational agriculture and guidance

One emphasis in educational policy for agriculture has been that every farm boy should be made into a better farmer. The criterion of success for the Smith-Hughes teacher in many agricultural communities is the proportion of farm boys that can be enrolled in vocational agricultural classes. Given today's surplus of labor and income depression in many localities, the economic growth criterion for successful education might better be the opposite; namely, that farm youth be trained for other opportunities and guided from agriculture. As a minimum, education at this level should be broadened to explain the relative level of incomes in different sectors of agriculture, and of agriculture as compared with other employment.

Vocational agriculture has had as its focus teaching the boy to be a better farmer on his home tract of soil. In many cases, the individual and society would benefit if he were told why he should, and how he can, move from this farming location to another. But more important, vocational concentration should be on training farm youth who will not be needed in producing food so that their abilities can be better used for goods and services that have relatively greatest demand in a growing economy. To be certain, food needs of the future require that new farmers enter the occupation to replace most of those who will retire and otherwise leave the industry. The competitive prospects for future

agriculture require that the farmer be even better educated and a more efficient manager that at the present. Agricultural education is required accordingly. But it is just as important that we systematically guide some boys out of agriculture. The vocational agriculture courses taken by many leaving the farm provides them with little training and sometimes no skills for the products and services in which they become employed.

An important need for many rural communities is an increased investment in vocational guidance, along with educational programs that emphasize skills and knowledge for nonfarm employment opportunities. Agriculture and home economics now are the main types of vocational training given in many rural high schools.[3] The emphasis on vocational agriculture relative to trades, industry and distributive occupations is particularly great in the low-income areas of Southern states. The value of this training is questionable for boys who will not return to the farm. In most agricultural communities there are from 2 to 4 boys who must leave the farm for each one who will be needed for replacement, if agricultural production is to be geared to potential demand and economic growth. Human resources can be improved to a degree approaching the limit only if a much greater investment is made in occupational counseling and if vocational courses of a nonfarm nature are greatly increased. Counseling needs to begin with students entering high school, rather than as a main contact at about the time of graduation.

4-H Club Activities

Historically, the main emphasis on youth in extension education also has been on farm skills. This activity is needed in the years ahead for the reasons mentioned above. But in order that a relatively larger portion of farm youth can have higher incomes and greater life satisfactions, as compared to subsistence on an undersized farm, 4-H activity needs to focus less on how to fatten a calf for the fair and more on developing knowledge about, and interest in, economic opportunities elsewhere. Since in some areas there are many more boys than are needed as farmer replacement, specialists in youth work might best have vocational guidance as their central training. The challenge ahead is to help the individual predict, comparing different activities through which he can sell his labor services, the production possibilities that represent his makeup. Prediction cannot end here, however. To tell the individual that he should follow farming because his production possi-

[3] For an indication of the relatively large public investment in vocational agriculture and home economics relative to trade and industry, see U.S.D.A. Special Report Development of Agriculture's Human Resources, *A Report on Problems of Low Income Farmers*. Washington, April, 1955. pp. 33-35.

bility curve extends further in this direction (i.e., that, representing his abilities, the marginal rate of substitution of farm production for other products is high), considers only half the relevant variables. If the price or returns ratio provides a revenue line with little slope towards the extreme of farming on the production possibility curve, the individual will have a higher return in the nonfarming activity. Of course, final analysis and recommendations must relate the individuals preferences (i.e., the slope of his indifference curves) to the slope of his production possibilities.

The individual as a consumer

Education directed at the individual as a consumer in society is just as important as that directed at him as a producer or resource. Education of the individual as a resource would be important, of course, even for a slave economy. However, in a society based largely on sovereignty of the consumer, this direction is not sufficient; a point not fully recognized in much current education. If engineers, for example, were to be viewed by society solely as resource units (much as concrete blocks or other material factors) we should shift away even from the few nontechnical courses now taken and concentrate even more on developing them as technical inputs for the national industrial machine. On the other hand, if engineers are to be considered as consumers, as well as resources, education needs to be tailored accordingly; with course work that develops their ability to understand their own preference systems and to express them effectively through the several choice mechanisms available in our society. Much of the same can be said about education directed at farm youth.

Adult classes, retraining and farm and home planning

Adult classes in vocational agriculture schools now provide a basis for extending skills or retraining persons in agriculture. With the economic growth impinging on agriculture as it does, these same general facilities should be used to provide retraining for persons who are now engaged in agriculture but know about, or are interested in, opportunities elsewhere. Retraining of persons who can then leave agriculture is important, in areas where farms are small and income is low, for increasing incomes of those who will remain in agriculture. In fact it is equally as important as providing adult education to promote the skills of those who will remain: the latter often can increase incomes sufficiently only if others leave agriculture to allow farm consolidations and attainment of scale economies. In some instance, resources used in adult retraining for nonfarm skills could be provided by the same vocational agriculture instructor who conducts evening classes for farmers. Hence, resistance

need not be encountered in "lessening the capacity" of current educational resources. Mainly, however, total educational resources need to be extended to provide a broader range of skill opportunities, for an activity that is as important socially as evening schools for farmers.

The extension services should redirect some of its work with young married couples similarly. Farm and home planning should emphasize off-farm employment opportunities for resources, as well as reallocations of these same resources within the existing firm-household complex. The portion of the agricultural population with the high mobility potential is, of course, young persons who have not yet committed their abilities for a particular line and have not yet acquired a fixed set of skills. Next in flexibility are young persons who have started farming but have not pushed their roots deeply into the community; have long working lives ahead and still have enough youth to switch from one to another skill. Farm and home planning should, as is true in some states, focus particularly on this group. A broad view of resource use and family welfare maximization is needed. From the families standpoint, it is important to show them where they will have higher incomes and greater satisfactions in leaving agriculture, as it is to explain how some can reorganize production and consumption patterns to increase dollar profit and household utility on the farm. Planning should help young families, before their flexibility declines greatly, decide whether their capital and managerial assets best fit them for farm or other occupations.

Auxiliary Programs

Maintenance of full employment expectations and information (education) on economic opportunities are the prime necessities in adjusting agriculture to the economic change foreseeable in the next two decades. However, other programs are needed to complement education, if optimum mobility is to be attained. As in the case of education, the overall machinery is available for accomplishing the task. While now being used for other purposes, it could become, along with proper educational activity, the basic framework of policy for agriculture. In the following paragraphs we outline some of the means that might complement education in increasing labor mobility and facilitating adjustment of agriculture to national economic growth. However, these complementary means are highly ineffective if farm people are not given sufficient educational services to provide the "broad picture" of economic adjustment and opportunity.

Old age and survivor's benefits

The focus of this paper is on increasing mobility of the flexible portion of the labor force. Transfers of labor have been and continue to take

place. But the flow will need to continue for many years. Public subsidy to agriculture should largely revolve around activities that catalyze this transfer, and speed it up where surplus labor is most dense. Although the basic solution of the "farm income depression" will come from preventing many farm youth from mistakenly entering agriculture, we should recognize that a large portion of the current labor force does not wish to and probably should not be considered as transfer potential. Many part-time farmers and older persons fall in this category. Few middle-aged owners will or should move; since their skills, capital and living patterns are less flexible and are deeply committed to agricultural pursuits.

In this connection, society may be obligated to compensate persons in agriculture. To the extent that depressed incomes in agriculture represent a natural law of economic growth, we can only guarantee that total national welfare will be increased either (1) if the benefiting nonfarm families gain more utility than is sacrificed by farm families (as a result of national economic growth and public investment in agricultural techniques, which together cause a relative lowering of farm income), or (2) if compensation is provided so that in the end those whose initial position is worsened will be left no worse off than formerly. However, rather than parity pricing and similar programs, another compensation possibility is current Social Security Administration machinery. If we could make an approximate inventory of persons who should not or never will leave agriculture, and if society firmly believes that compensation is due agriculture because of the burden of economic growth falling on the industry, the age at which social security payments begin might be lowered from 65 to the appropriate level. This system would not tie the interproduct use of resources in agriculture to consumption and technical patterns of the past. Given the conditions above (that the persons concerned are those who should not or would not leave agriculture) the system would not freeze resources in agriculture. The condition mentioned might not be easily attained. However, even if some "errors" were made in designation of individuals, or even if anticipations led some surplus labor to remain in agriculture, the misuse of resources would be less than under present price policies where farmers are encouraged to stay in agriculture to receive parity subsidies. With the age for social security payments lowered to a particular level, it would not be left permanently at this level. It would be moved up progressively to reach 65, the level for the rest of the population.[4] In other words, the rest of

[4] It might be said that if some agricultural workers can claim benefits at an earlier age, other persons would ask for similar treatment. However, nonfarm persons recognize that farmers receive support prices and other subsidies apart from the market and can ask for similar treatment here. We do not examine the political acceptability of these alternatives, but simply outline the various mechanisms that already are in

the farm labor force would be warned that the same arrangement would not apply to it when it reaches the "lower age"; but that if its income is low, advantage should be taken of special education or mobility subsidies with movement to other employment.

Unemployment compensation and transportation subsidy

Although current Social Security Administration machinery could provide an improved compensation means for agriculture (for any sacrifice it makes in behalf of general economic growth and gain) than current parity pricing, it also could provide the means for helping move those persons who should no longer be employed in agriculture. Unemployment compensation could be paid persons who leave agriculture to seek employment in other industries and at other locations. This mechanism would be highly more efficient than current subsidies that keep the same people in agriculture. Over a few years, it could require a smaller public outlay than the "continuous support-price" scaffolding in prospect. Coupled with this unemployment compensation to provide income while the worker seeks off-farm employment, advances equal to current on-farm subsidies might be paid to cover costs of transportation. Rather than pay a subsidy of $500 per year for the next five years, we might tell the family: "Here is $1500, available immediately if you accept an off-farm position." But to prevent abuse of the privilege, both types of payment should be allowed only once.

Other mechanisms also exist. For persons making interregional transfers one possibility is to provide loans to cover transportation for moving and living costs until employment is obtained. This is a mechanism that does not have a basis in precedent, as does unemployment compensation under existing machinery. Although indentured servitude is not recommended as an acceptable mobility means, it drew a large proportion of emigrants to the United States and was, in effect, such a procedure. The indentured servant received his subsistence while he worked a contracted period of time to repay his transportation and upkeep costs. Another mechanism with experience behind it is the postwar G.I. on-the-job training. During 1942-50 payments provided living costs and retraining opportunity for persons who wished to make productive transfers of their skills and locations. We mention these to indicate again that the means required do not require any "revolutionary social measures"; but generally are represented in public legislation accepted in the present or past.

Extended employment services

A very great expansion is needed in services to inform people about

existence and could contribute more to the solution economic growth problems than the general body of policy means now being employed.

job openings and personal adjustments required for new employment and new living environments. Emphasis should be on interregional job communication. The existing facilities of the state employment services and the Bureau of Employment Security of the Department of Labor can, if extended to a broader national basis, provide another means to supplement education in adjusting agriculture to economic growth. The two are not substitutes for each other. Education and vocational guidance should be used to give individuals broad and long-run understanding of the working of the economy, and the prospects and needs in various industries and services. The State Employment Service and Bureau of Employment Security should provide a broader and more current indication of where nonfarm positions are. The Bureau has 1,700 local offices and is affiliated with state employment services. Yet it has no special program for farm people, except information on job opportunities elsewhere for migratory farm laborers. State employment services, while concentrating on labor requirements of the locality, do provide some "clearing house" information with other localities. During the war period the Employment Service helped an important number of farm people find positions in rural and urban industries. Mobility during the war also was encouraged through provision of transportation costs and job guarantees. As an aid to the peacetime mobility required for agriculture, this information and the monetary and job aids need to be extended and made more comprehensive and detailed. Our present employment services are too little concerned, in respect to labor in agriculture, in indicating the existence and conditions for off-farm employment. Of course, some restrictive state and local legislation stands in the way of using the employment services more effectively. For instance, scattered states have laws that allows recruiting of agricultural labor, to be used elsewhere, only if a fee is paid for this privilege and if the county agent gives permission.

As a mobility aid, the state employment service should be expanded to emphasize nonfarm opportunities, more than placement of seasonal farm labor. The ideal would be a "market clearing house," similar to commodity and stock markets, to reflect the location and nature of positions, wage rates and skill requirements. The prospective employee could be "fully as informed at the moment" as traders in the markets mentioned. This degree of "finess" is impossible, of course, but it serves as a goal to be approached. These "market quotations" provided by the state employment services or the Bureau of Employment Security should be complemented by information relating to consumption and the household, with the Agricultural Extension Service helping to carry information to farm people. The latter information should indicate the nature of living conditions and adjustments that might be required. Its purpose

would be to prevent families from moving where their living patterns and social values would be inconsistent with those of the new community. This information would help prevent "waste motion" that otherwise occurs as the individual or family becomes discouraged and returns to the old community. It would help individuals find communities that match their own preferences and value systems.

Information and service should not be restricted to the "sending end" of transfers, but should be extended to the "receiving end" as well. A great deal of uncertainty exists as interregional transfers are made; in respect not only to employment opportunities, but also to making friends, finding housing, becoming integrated into a community, and so forth. Lessening of this uncertainty at the "receiving end" would increase interregional labor mobility. This aid should be provided by a broad, well integrated national employment service. But, again, as for most of the elements outlined here, a completely new machine need not be invented. This type of service, while far from perfect, already is being used in helping to relocate Indians and in moving them from reservations to industrial employment.

AGRICULTURAL LABOR FORCE IN THE USSR

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AMONG Western great powers, the Soviet Union is one of the most rural countries, but it is more urbanized than Eastern European and the Asiatic countries and there is a gradual migration from villages to cities. This shift in population is due to a planned program of rapid industrialization of the country, mechanization of agriculture, and the creation of small settlements such as mining communities, workers' residential centers, etc., which in Soviet statistics are classified as urbanized settlements.

TOTAL POPLUATION OF THE USSR[1]

Date	Number in millions			Percent of total	
	Total	Urban	Rural	Urban	Rural
1926 (Census)	147.0	26.3	120.7	17.9	82.1
1939 (Census)	170.6	56.1	114.5	32.9	67.1
1940 (Estimate)	191.7	60.6	121.1	31.6	68.4
1955 (Estimate)	196.0	84.6	111.4	43.2	56.8
1956 (April)	200.2	87.0	113.2	43.4	56.6

[1] *Narodnoye Khozaystvo SSSR*, Moscow, 1956, p. 7. In the 1940 estimate are included western parts of Ukraine, White Russia, Moldavia, Lithuania, Latvia, and Estonia. Regions which were transferred to Poland in 1945 and where 1.4 million resided are excluded. The same source, page 27, estimates January, 1955 urban population at 84.6 million and by assuming the same urban-rural ratios for 1955 as they were in April, 1956, total and rural 1955 populations have been estimated by the author.

Prior to the latest official Soviet report on population published in 1956, various Western observers estimated the population of the Soviet Union at a much higher level.

Below are listed the most recent estimates prepared by students of Soviet population:

Name	Estimated period	Number in millions
Kulischer, Eugene	End of 1949	200.0[1]
Eason, Warren	1950	190.0–205.0[2]
Schwartz, Harry	1953	210.0[3]
Library of Congress	End of 1953	212.0[4]
Grossman, Gregory	1954	214.0[5]
U.S. Economic Commission for Europe	December, 1954	216.0[6]

[1] *Foreign Affairs*, Vol. 31, No. 1, October, 1952, p. 67.
[2] *Soviet Economic Growth*, 1953, p. 102.
[3] *Russia's Soviet Economy*, 1954, p. 650.
[4] *Trend in Economic Growth*, The Joint Committee on the Economic Report by the Legislative Reference Service of the Library of Congress, Washington, D. C., 1955, p. 6.
[5] *The Annals of the American Academy of Political Science*, January, 1956, p. 64.
[6] *The Washington Daily News*, June 7, 1956.

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The most recent estimate of the Soviet population was about 20 million above the figures officially reported by the Soviets.[2] Most of the Western observers believe that if the 1956 Soviet population estimate is correct, then Russia's World War II losses, which have been estimated by experts at 20 million, were much higher. Again, many of the experts claim that the official 1956 Soviet figure is too low and does not agree with published data available on education and elections. The interesting point is that many of the population experts assume that the official Soviet population figures after the 1939 Census are less reliable than the published data on education, elections, birth and death rates, etc. On the other hand, students of industrial, transportation, agricultural, etc., expansions tend to accept recent Soviet population figures but reject nonpopulation data.

It is not known for certain what method was used in the preparation of the latest population figure by the Soviets. Another unanswered question is whether or not the military and civilian personnel outside of the USSR was counted and whether or not the estimated population of 200.2 million includes "present" or "permanent" population. A part of the Soviet population is in a fluid state, moving from place to place either for short or long periods of time. These may be administrative personnel on official trips, students, demobolized personnel of the armed forces, tourists, or persons seeking better jobs elsewhere. Also there is no evidence as to whether or not the prison population are included in the recent population figures. This section is not dealing with detailed evaluation of the total Soviet population. However, the absence of answers to the above questions and the total absence of any information necessary for evaluation of the 200.2 million in light of the methodologies, there are strong feelings favoring to conclude that the April, 1956 given population is inaccurate and underestimated.[3]

There has been less speculation on the size of the agricultural labor force than of the total population. In the first place, unlike demographers who have well-developed methods suitable for making estimates of the total population, students of the Soviet agricultural labor force have none. The technique used in the United States for making estimates of the size and change in the labor force can not with certainty be applied to the Soviet Union because of major structural differences. Agricultural production in the Soviet Union is found not only on the collective and state farms, and the various state organizations and enterprises, but also being conducted by nonagricultural workers and employees. A part of

[2] *The Washington Post and Times Herald,* June 7, 1956.

[3] *Narodnove Khozaystvo SSSR* (The National Economy of the USSR) consists of 262 pages and was submitted for publication on April 6, 1956. Preparation of the text was probably made sometimes prior to April, 1956 and there was scarcely the time to verify and to revise the data to include information available for April.

the total farm labor force that normally would be classified as agricultural workers in the United States, is in the Soviet Union grouped in the industrial labor force. An example of this is the classification of workers and employees of the machine-tractor stations (MTS) and state farms. Again, there are a number of persons who are not members of collective and state farms, yet reside in rural areas. These are independent peasants, various handicraft and forestry workers, and rural intelligentsia such as teachers. In addition, there are pensioners who together with above persons are frequently employed in agriculture during the harvest.

SOCIAL DISTRIBUTION OF NONINDUSTRIAL POPULATION

Class	1940		1955	
	Number in millions	Percent	Number in millions	Percent
Total	131.1	100.0	111.4	100.0
Collectivized peasantry and cooperative handicrafts	100.0[1]	76.3	80.7[2]	72.4
Independent peasants, noncooperative handicrafts, and skilled workers	5.0[1]	3.8	1.0[2]	0.9
Others, not elsewhere classified	26.1[3]	19.9	29.7[3]	26.7

[1] Estimated by the author using the same social distribution pattern as given for 1939.
[2] *Narodnoye Khozaystvo SSSR*, Moscow, 1956, p. 19.
[3] Difference between total and peasants-handicrafts class.

Between 1940 and 1955 the total rural population declined by 11.8 percent. Members of collective farms and cooperative handicrafts with dependents decreased by 12.1 percent and the size of independent peasant groups, noncooperative handicraft workers, and skilled workers and their dependents were reduced from 5 million to 1 million. However, the unclassified groups increased by 11.4 percent. In 1940, the Baltic states and parts of the Ukraine and White Russia were still in a flexible state and many rural residents were not collectivized whereas in 1955 this was not tolerated. Again, in 1955, better services in education, forest protection, medical care, etc., were more readily available than in 1940, requiring a greater number of rural intelligentsia. Also in 1955 a greater number of pensioners resided in the country than in 1940. Of course, many of the independent skilled workers such as carpenters, brick layers, etc. lived in urban settlements, but the number of these was not great enough to significantly upset the social distribution of the total rural population. There is no immediate technique by which these independent skilled workers living in urban areas could be separated from those in rural areas. In 1955, the USSR had more than 100,000 independent peasant households or roughly about 500,000 persons.[4] Thus, there

[4] Narodnoye Khozaystvo SSSR, Moscow, 1956, p. 99.

were approximately 500,000 persons both in the noncooperative handicraft and skilled-worker groups and noncooperative handicraft group being the largest, would leave a fraction of the total for the independent skilled workers. At the beginning of 1956 the social distribution of the Soviet population and their dependents was estimated by the Soviets as follows:[5]

Workers and employees	"about"	117 million
Collectivized peasants and cooperative handicrafts	"about"	82 million
Independent peasants and non-cooperative handicrafts	"about"	1 million
Total	"about"	200 million

The question of the economically active population engaged in agriculture, forestry, and other related activities is more difficult to understand. The definition of "economically active" persons and most of all the contribution of their efforts to total farm labor force are the least comprehensible in the Soviet statistics. According to the Soviet definition, the age groups with the highest proportion of economically active persons is between 18 and 56 years of age, for both sexes. Next are the men and women over 56 years of age, followed by the 15 to 18 year age group, and finally the youths of 12 to 14 years of age.[6] The children between 12 and 16 years of age are not permitted to work on the farms more than 50 full working days annually whereas for the other groups the annual minimum is 150 working days. In addition to the local farm labor force, many areas depend upon housewives, factory workers, employees of various state organizations, and school children from nearby urban centers to help during the harvesting season. These are temporary workers, yet they boost the existing farm labor force when it is needed the most. The contribution of children and temporary and seasonal urban workers to the permanent farm labor force is difficult to estimate. The economically active farm labor force in the Soviet Union is estimated as follows:[7]

Category	1940	1955
	(millions)	(millions)
Total number of employable persons in agriculture, forestry, individual plots, and MTS	111.9	87.4
Number of persons working on collective farms and their household plots	86.6	73.5
Number of independent peasants and non-cooperative handicrafts	18.2	0.8
Number of nonagricultural workers and employees working on their own plots	4.8	7.2
Number of workers in state farms and state-operated supplementary enterprises	1.8	2.8
Number of workers in MTS	0.5	3.1

[5] *Ibid.*, p. 19.
[6] *Voprosy Kolkhoznogo Stroitel'stva v SSSR*, Moscow, 1951, p. 278.
[7] *Narodnoye Khozaystvo SSSR*, Moscow, 1956, pp. 188, 190.

In 1940, 85.4 percent of the total rural population was economically active either on full-time or part-time basis compared with 78.4 percent in 1955. In 1940 and 1955 approximately two-thirds of the total rural population was working on collective farms and on individual plots owned by the members of the collective farms. However, the actual number of economically active collectivized peasants were fewer in 1955 by 13.1 million. This suggests that participation in farm work by collectized farmers in 1955 had considerably increased.

The drain on the economically active agricultural labor force came from many sectors. A large part of military manpower during World War II was drafted from the collective farms and suffered heavy losses. After the war many demobilized Red Army personnel failed to return to the land and accepted jobs elsewhere. Beginning with 1950, collective peasants passed through a merging process of combining small collective farms into larger units. During this process, the rights of possession of individual plots were ignored and many collectivized and independent peasants and displaced farm officials dissatisfied with the program, left the farms and joined the nonagricultural labor force. Then, in 1953, more than a million skilled farm workers such as tractor drivers, combine operators, and the like, were permanently transferred from collective farms to MTS. During the 1954-1955 period, some of the peasants were pooled into newly organized state farms in the eastern regions. Again, due to additional investments in agricultural machinery and equipment and, to some degree, a change in farming practices and greater participation in the farm work by the members during the postwar period, productivity per able-bodied member of collective farm was increased considerably. Between 1940 and 1950 the gross output per able-bodied collectivized peasant was increased by 30 percent and between 1950 and 1955 another increase of 38 percent was achieved.[8] During the 1940-1955 period, the total Soviet sowed area increased by 23.5 percent, whereas the number of able-bodied peasants on collective farms declined by 16.1 percent. Therefore, fewer peasants were forced to intensify their efforts on a larger area, resulting in greater output per man. The fact that, according to Mikoyan, in 1953, more than 500,000 members of collective farms daily attended collective farm markets, selling their produce, suggests that even in 1953 there was an ample supply of farm labor force which was not fully utilized by the Soviet farm leaders.[9] But the most striking fact of peasant migration to urban

[8] *Voprosy Ekonomiki*, No. 8, 1953 and *Narodnoye Khozaystvo SSSR*, Moscow, 1956, p. 102.

[9] *Pravda*, April 27, 1954.

centers is found in Khruschev's speech made in 1955, in which he has stated that during the 1950-1955 period, more than 9 million persons moved to the cities from the villages, whereas the annual growth of the total Soviet population was a little more than 3 million.[10] As a whole by 1955 many peasants dissatisfied with radical changes on the farms and encouraged by better economic opportunities in industry left farms. The turnover of this industrially unskilled labor force was so great that the administration was unable to keep workers on the job and finally abolished its system of forceful holding or freezing and permitted workers to leave jobs on two weeks' notice.

Since 1950, agriculture in the Soviet Union underwent an unpublicized yet internal revolution of major proportion. There were so many changes, adjustments, and new practices dealing with agriculture that a descriptive analysis of these would take many more pages than anticipated for this paper. However, at least a few of the major changes should be mentioned briefly.

The most well-known of all, of course, is the so-called "Go East Young Man" policy advanced by Khruschev in 1954 which called for opening of virgin and unused lands in the eastern parts of the USSR. The main target was Kazakhstan where about 67 percent of all virgin and unused lands in 1955 were put under cultivation by newly formed state farms and existing collective farms. During the 1954-1955 period over 33 million hectares of such lands were plowed in the all of the USSR.[11] The bulk of the labor force for the new state farms was recruited from urban centers, demobilized Red Army G.I.'s, and only a small number of collectivized peasantry. Many versions of the basic reasons for the "Go East Young Man" policy have been propounded. The official version, as expressed by Khruschev in his major speech on February 7, 1955, states that the country needs more grain not only for bread but for livestock, for foreign trade, and also for additional grain reserves. At the same time he implied that since the urban population increases have been at such a rapid rate there are not enough jobs for all workers in the cities. As an additional problem supplementary to the lack of adequate jobs is the seriousness of juvenile delinquency. This is the major reason why skilled factory workers, who were so indispensable just a few years ago, were taken off their jobs and shipped to the east to become farmers. This action created greater opportunities for those persons who just joined the ranks of the labor force in the cities.

Another, but less publicized change also advanced by Khruschev in

[10] *Ibid.*, February 7, 1955.
[11] *Narodnoye Khozaystvo SSSR*, Moscow, 1956, p. 117.

1950 was the merging of small collective farms into larger units. The process of merging small farms is not new in the Soviet Union. This was a continuous process since 1934 in many regions. In 1950, however, this trend took on the form of an avalanche. The main Soviet reason for this move may be boiled down to the fact that such mergers result in an increase in the cultivated land area per worker using the same factors of production. It intends to increase productivity of farm labor by more efficient use of farm machinery and personnel. For example, when three collective farms are merged into one, there is only one chairman needed, the number of cows per milk-maid would be increased, and the planning for larger collective farms becomes more effective. Thus this technique tended to tighten the organizational and administrative structure of the collective farms by bringing them under a more disciplined party control, whereas in the past many of the small collective farms were without strong political organizations. But at the same time it facilitates the construction of schools, hospitals, clubs, roads, and introduction of better farming methods. However, with the tightening of political and economic control over the larger farms by the state, individual members of collective farms have lost personal contact with farming problems existing on smaller farms and became factory-like workers to carry out decisions made by the state.

While the merging of the collective farms was in process, it was necessary to reorganize the structure of MTS. In 1953, members of collective farms who were employed seasonally by the MTS as tractor drivers, combine operators, etc., were permanently transferred to MTS. In addition, agricultural specialists such as agronomists and the like, who were employed by the collective farms and various administrative organizations in nonagricultural occupations were transferred to MTS. This created a maladjustment in structural organization of individual enterprises and confusion in the minds of transferred workers. Productivity and morale were lowered and realizing poor judgement in making these shifts, the Soviets permitted these specialists to return to collective farms.

Beginning with 1950, the Soviets introduced a new method for irrigation of farm land. Under the new method ditches are made only when irrigation of fields is required and after irrigation these ditches are leveled off and plowed with the rest of the land. The Soviets claim that this method adds to cultivated area not only from the land occupied by ditches but from the margin of land on each side of the ditches. The claim is that it also facilitates the usage of large-scale farm machinery more effectively. Now only the plots of cultivated land containing not

less than 40-60 hectares of grain and 20-40 hectares of cotton are permitted to have permanent irrigation canals and ditches. In cotton areas requiring intensive irrigation such as the Fergana Valley of Uzbekistan, permanent irrigation systems are permitted for not less than 5 hectares. The Soviets claim that the old irrigation practices wasted about 30 percent of water whereas under new practices it is reduced to about 10 percent.

As a result of preparation for war, in 1939 and 1940, the Soviet economy was put under the regional self-sufficiency policy which was in effect up to 1955. Under this policy regions were forced to grow crops which historically were not produced there in large amounts. For example, a region poorly adapted for the growing of sugar beets was forced to grow them to provide the local market with sugar and therefore reduce the demand for transportation facilities required for imports of sugar. In 1955, Khruschev reversed this policy and established the regional economic advantage policy, thus relieving many areas of producing crops not economically suitable there.

In 1956, the Soviets launched a program for the organization of "distribution cooperatives." The purpose of these cooperatives was to eliminate the need for the peasant in a collective farm to market his own surplus products. The procedure was established to take his surplus to a distribution cooperative, which in turn sells it on the market or to the state and the only cost to the peasant would be that of the selling expenses by the distribution cooperative. In the middle of 1956, upon suggestion from the Soviet leaders, many collective farms started discussing the practicability of revising the original 1936 Model Statute of an "Agricultural Artel" which had been, up to this time, the guiding light for collective farms. The main purpose of the revision was to reduce the size of the individually owned plots and to increase the number of working days required of each member of collective farm.

Beginning with 1953, in order to stimulate production of livestock, the Soviets had reduced the "required delivery" of livestock to the state and increased payments for such deliveries, but at the same time they revised the old method of calculation of the amount of delivery to the state. The present method of calculation of "required delivery" to the state is based on the possession of every 100 hectares of cultivated land rather than the gross harvest. For some crops, these "required deliveries" are based per every 100 hectares of land in possession. Thus, although rate of delivery has been reduced, the peasants must deliver from the larger area whether the land is cultivated or not. As a whole, a drastic reshaping of the organization of agriculture is taking place, affecting plans and practices in existence for the last 20 to 30 years.

STRUCTURE OF THE COLLECTIVE FARMS[1]

	Unit	1940	1950	1955
Number of all collective farms including fishing and industrial collectives	Thousand	236.9	123.7	87.5
Number of agricultural collective farms only	Thousand	235.5	121.4	85.7
Number of households in agricultural collective farms	Million	18.7	20.5	19.7
Number of households per agricultural collective farm	Actual	81	165	229
Average number of able-bodied workers per household	Actual	4.6	—	3.7
Number of sowed hectares per collective farm	Actual	492	967	1,699
Total number of working days credited to workers:	Million	9,319	8,286	10,850
Field and orchard crops	Million	5,612	4,755	5,650
Livestock, raw silk, and fishing	Million	1,142	1,408	2,808
Care of draft animals	Million	622	480	548
Construction and repair of farm buildings, implements, irrigation, and land conservation	Million	283	350	540
Supplementary and industrial farm enterprises	Million	234	204	322
Administration and services	Million	799	497	505

[1] *Narodnoye Khozaystvo SSSR*, Moscow, 1956, pp. 122, 129. Average number of able-bodied workers per collectivized household was estimated by dividing number of persons working on collective farms and their individual plots by the number of households.

The above table indicates that in 1955 the Soviets had more concentrated farm organizations than in 1940 or 1950 with fewer but larger collective farms, each owning more land and less expenditures in terms of labor for administration and servicing. In 1940, 60.2 percent of all collectivized farmers was devoted to field crops, orchards and vineyards and only 51.8 percent in 1955. During the same period livestock, production of raw silk, and fishery comprised 11.8 percent and 25.9 percent respectively, and the care of draft animals has declined from 6.4 to 4.6 percent.

As a result of the reshaping of collective farms, the state farms and supplementary state-operated enterprises were affected too.

STRUCTURE OF THE STATE FARMS AND STATE-OPERATED ENTERPRISES[1]

	Unit	1940	1950	1955
Total number	Actual	49,995	129,524	125,153
Average annual labor force	Thousand	1,760	2,425	2,832
Total sowed hectares	Thousand	13,259	15,921	29,371
Number of tractors	Thousand	87	112	173
Number of grain combines	Thousand	28	38	74
State farms only:				
Total number	Actual	4,159	4,988	5,134
Average annual labor force	Thousand	1,373	1,665	2,054
Total sowed hectares	Thousand	11,559	12,894	25,846
Number of tractors	Thousand	74	74	130
Number of grain combines	Thousand	27	33	63

[1] *Narodnoye Khozaystvo SSSR*, pp. 134–136.

Between 1940 and 1955 there was a rapid increase in the state-operated enterprises, but expansion of the labor force in this sector was at a less dramatic rate. The greatest reorganization in the state farms took place during the 1954-1955 period when 918 state farms were reorganized. Of this number, 515 small state farms were merged into larger units, 192 state farms were reclassified as supplementary state-operated enterprises, and 65 state farms were abolished entirely. Thus, due to reorganization of state farms during the whole 1951-1955 period, 772 state farms were abolished and the actual increase was only 146 state farms.

With reorganization of collective and state farms, the MTS also passed through a transformation period to fit the new demand for their services. The reorganization of MTS took a different form. Their size was considerably increased, but the most important point was that they were given new responsibilities in planning and servicing collective farms. They actually became the watch dogs of production on the farms.

STRUCTURE OF MTS [1]

Major items	1940	1950	1955
Number of MTS	7,069	8,414	9,009
Average annual personnel	537,000	705,000	3,120,000
Number of tractors	435,000	482,000	669,000
Number of grain combines	153,000	173,000	280,000

[1] *Narodnoye Khozaystvo SSSR*, pp. 138, 139, 147.

Between 1940 and 1950 the number of MTS increased by about 19 percent and only 7 percent between 1950 and 1955. During the 1940-1950 period the permanent labor force in MTS increased by approximately 31 percent whereas between 1950 and 1955 this increase jumped by 4.4 times. Between 1940 and 1955 the number of tractors in all MTS increased by 54 percent and grain combines by 83 percent. During the 1940-1955 period, the number of tractors per MTS was increased from 61 to 74, or an increase of 22 percent, and the increase in grain combines was from 22 to 31 or an increase of 43 percent. Thus, in 1955 every MTS had more basic mechanized equipment than in 1940. But the major reorganization of MTS took place in 1952.

On July 1, 1952, there were 8,939 MTS and special mechanized stations. Of this total, 8,722 served collective farms and 217 were specialized stations serving forestry enterprises. At a later date these special mechanized stations were reorganized for work on the collective farms or were attached to various timber and land-reclamation enterprises. Because of the rapid expansion of state farms in the eastern regions and the scarcity of farm machinery, some regions such as the White Russia and Karelo-Finnish Republics decreased the number of MTS by transfer-

ing them to the east. But the most dramatic change in MTS was the increased number of permanent personnel which came as a result of the transfers from other various occupations to MTS in 1953.

Perhaps a few words devoted to agricultural specialists in the USSR may serve to indicate the growth of these groups in the Soviet Union. These specialists comprise agronomists, zootechnicians, veterinary and forestry personnel either with college or equivalent special training.

NUMBER OF SPECIALISTS IN THE SOVIET AGRICULTURE[1]

	1940	1955
Total specialists:	163,000	413,000
College trained	70,000	159,000
Trained in specialized schools	93,000	254,000
Employment by occupations in agriculture:	116,000	341,000
MTS and collective farms	19,000	204,000
State farms and state-operated firms	16,000	35,000
Organizations serving agriculture	13,000	37,000
Forestry	8,000	24,000
Scientific and educational institutions	7,000	16,000
Administrative organizations	53,000	25,000
Other, unclassified occupations	57,000	72,000

[1] *Narodnoye Khozaystvo SSSR*, p. 151.

Between 1940 and 1955, agricultural specialists more than doubled in number. In 1953, with the reorganization of the whole Soviet agriculture, there was an urgent need for technical personnel, but various ministries, offices, trusts, and local administrations employed 107,000 of these specialists. In these sectors of the economy the pay and working conditions were better than on the farms, and then by a stroke of the pen many of these specialists were removed from their easy jobs and sent to the country. As a result of this program, Soviet agriculture has more specialists now than in the past.

The role of women in agriculture in 1955 has declined since the war, but women are still the largest source of available labor reserves on farms.

PERCENT OF WOMEN IN AGRICULTURAL LABOR FORCE[1]

	1940	1950	1955
MTS	11	16	19
State farms and state-operated supplementary enterprises	34	49	46

[1] *Narodnoye Khozaystvo SSSR*, p. 191.

The participation of women in work on collective farms should be greater than on state farms and in state-operated supplementary enter-

prises. A rough estimate may be put at 55-60 percent for the collective farms.

Agriculture in the Soviet Union is still in the process of adjustment resulting from a rapid succession of various changes and it will take several years before information giving the results may become available. However, there should be no doubt that when all the changes are materialized, the Soviet agriculture will emerge with a new and striking farming organization and the socio-economic pattern of the collective farms and other related organizations will be reenforced by a greater dose of the Marxian ideology than in the past.

A COMMENT ON THE FTC'S REPORT ON MERGERS WITH SPECIAL REFERENCE TO DAIRY MERGERS*

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IN 1955 the Federal Trade Commission released its second post-World War II report on mergers.[1] This comment supplements some of the statistics of that report rather than reviewing it in its entirety.

The discussion is especially concerned with the data underlying Chapter II of the report. The chapter has two purposes: first, to "bring up to date a long-term statistical series on mergers and acquisitions which goes back to 1919[2] and, second, to make an analysis of the structural characteristics of the merger movement during 1948-54."

Among the important findings of Chapter II are these: (1) The pace of merger activity in manufacturing and mining quickened after 1949, and by 1954 mergers reported in the financial manuals were three times as great as in 1949. (2) Nearly two-thirds of all reported acquisitions during 1948-54 were by companies having assets of more than $10 million. (3) About one-fourth (492) of all recorded mergers were made by firms classified in the nonelectrical-machinery (249) industries and in the food-and-kindred-products (243) industries.

These findings must be qualified, however, because the data on which they are based admittedly have statistical shortcomings. Mergers by small concerns are especially understated. This bias occurs because only mergers reported in *Moody's Industrials* and *Standard Corporation Records* are studied. The FTC recognizes that using only these sources yields a bias, and clearly warns the reader:

> It must be recognized that what appears to be a relatively sizeable number of mergers and acquisitions are not reported in the financial manuals comprising the sources of the 1919-54 mergers series. Generally speaking, the presumption is that most of the more important acquisitions are reported in the financial manuals and that the *unreported* ones represent the absorption of distinctly smaller enterprises. In the words of the TNEC Monograph, "At any rate the records are probably correct as to trend."[3]

Here I wish to supplement the FTC's study in two ways: I shall first give some indication of the extent of "unreported" mergers in one im-

* Giannini Foundation Journal Paper No. 159.

[1] Federal Trade Commission, *Report on Corporate Mergers and Acquisitions* (Washington: 1955). It released its first report in 1948: *The Merger Movement, A Summary Report* (Washington: 1948).

[2] Willard Thorp's *TNEC Monograph No. 27*, Part III, "The Structure of Industry" (1941) covered the period 1919-39, and the FTC's 1948 report extended Thorp's series to 1947.

[3] *Ibid.* Emphasis added.

portant industry during 1948-54; and second, try to determine if the exclusion of such "unreported" mergers seriously affects the implications of the FTC's evidence of mergers in this industry during 1948-54.

FTC Statistics on Dairy Mergers

For these purposes I have chosen the dairy industry because of its importance and the availability of data on it. But a word of caution. The structure and organization of this industry is obviously very different from that of many others. Therefore, generalizations based on the findings presented here as to the accuracy of the FTC's study must be made cautiously.

On the other hand, the information presented here should interest students of industrial structure, even apart from its implications for the FTC's study. Dairy mergers are an integral part of the current merger movement. During 1948-54 it was one of the top merger industries. Of the 1,770 mergers recorded by the FTC during 1948-54, ninety-seven (5.5 per cent) involved dairies. Moreover, the FTC reported that the country's two most active acquirers during this period were dairies. According to the FTC, Foremost Dairies, Inc. paced the recent merger race with forty-eight acquisitions; Borden came in second, with seventeen. National Dairy Products ranked twelfth, with eight to its credit.

In Table 1 are listed the various firms the FTC reported as making dairy acquisitions during 1948-54. Acquisitions by all but the dairy cooperative and "all others" classification were by companies with assets

TABLE 1. SALES, ASSETS, AND ACQUISITIONS OF SELECTED DAIRIES, AND ACQUISITIONS OF DAIRY COOPERATIVES AND ALL OTHER DAIRIES, 1948–1954

Company or group	Size of Firm				Per cent increase in sales	No. of mergers reported by FTC	Per cent all FTC	More complete record of mergers	Per cent all dairy mergers
	Assets[a]		Sales						
	1948 (millions)	1954 (millions)	1948 (millions)	1954 (millions)					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foremost Dairies, Inc.[b]	$ 10.9	$125.0	$ 33.0	$ 353.6	971.5	49	50.5	85	8.0
Borden Co.	242.1	301.1	649.6	776.8	19.6	17	17.6	59	5.5
National Dairy	317.6	446.5	986.4	1180.0[c]	19.6	8	8.3	19	1.8
Arden Farms	25.6	55.7	90.4	195.1	115.8	4	4.1	15	1.4
City Products Corp.	57.6	67.0	78.5	80.8	2.9	4	4.1	8	.7
Carnation Co.	82.7	111.4	260.0	310.0	19.2	4	4.1	24	2.3
Fairmont Foods	35.1	35.2	115.7	94.2	(18.6)	3	3.1	9	.9
Beatrice Foods Co.	39.4	69.1	192.9	287.4	49.0	3	3.1	62	5.8
Abbotts Dairies	13.6	17.8	—	—	30.9[d]	1	1.0	4	.4
Pet Milk Co.	50.1	51.5	153.5	167.2	8.9	0	0	7	.7
Swift & Co.						1	1.0	6	.6
Dairy Cooperatives						1	1.0	224	21.1
"All others"						2	2.1	540	50.8
Total						97	100.0	1062	100.0

[a] Sales and assets figures for Dec. 31, 1948 and 1954, except for Beatrice and Fairmont, which are for Feb. 28, 1949 and 1955. *Moody's Industrials.*

[b] Foremost sales and assets reported as if companies it acquired in 1954 "had been merged for entire year."

[c] National's assets and sales for 1948 are not comparable, because its Canadian holdings were excluded before 1952. In that year, its Canadian sales amounted to $30 million. I have deducted $30 million from its 1954 sales. But its resulting sales for 1954 likely still overstate its actual growth somewhat.

[d] No sales figures available. This represents its increase in assets.

exceeding $10 million in both 1948 and 1954. And the four largest dairies in 1954—all having assets of more than $100 million—made 80 per cent of all dairy mergers recorded by the FTC.[4]

A tempting inference from these facts, even after recalling the FTC's warning about considerable error, is that practically all dairy acquisitions were made by the industry's four largest dairies. But a more complete recording of dairy mergers demonstrates that such an inference as to the structure of this movement is completely unwarranted. On the contrary, by far the greatest *number* of dairy mergers were made by small (assets less than $10 million) and medium-sized (assets between $10 and $75 million) dairies.

In column 9 of Table 1, I have compiled a more complete record of dairy mergers than the FTC's list. My list includes 1,062 acquisitions reported in six of the country's leading dairy journals and other sources.[5] Significantly, this figure is more than half as great as all manufacturing and mining mergers recorded by the FTC for 1948-54.

Shortcomings of FTC Data

These data demonstrate two obvious shortcomings of the FTC's statistics on dairy mergers. First, even its records of acquisitions by large dairies are very incomplete.[6] The nine large and medium-sized firms that

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[4] This list of acquisitions is from the FTC's worksheets as reported in: *Corporate and Bank Mergers* (pp. 48-57), Interim Report of the Anti-trust Sub-committee (Subcommittee No. 5) of the Committee on the Judiciary, House of Representatives, 84th Cong., 1st Sess., pursuant to H. R. 22.

[5] The noncooperative mergers were reported in the *Dairy Record, Ice Cream Review, Milk Plant Monthly, Milk Dealer, Southern Dairy Products,* and *Western Dairy Foods.* Statistics on mergers by dairy cooperatives are based on a forthcoming study by the author on the importance of consolidations and acquisitions in the growth of agricultural cooperatives. The definition of mergers used here is the same as that used by the FTC in its chapter II. The FTC included acquisitions of "whole companies, whole subsidiaries, and whole company divisions," irrespective of legal form of either the acquired or acquiring companies (p. 38).

[6] The FTC did not estimate the accuracy of mergers recorded in Chapter II. But in Chapter III, "The Nature of Acquisitions and Mergers Between Jan. 1, 1951 and July 31, 1954," where it used a broader definition of mergers ("any parts of companies") and used additional merger sources than Chapter II, it stated: "Those files certainly do not cover all acquisitions; indeed, they very well may omit a greater number of acquisitions than they include. But all acquisitions of large properties are included, and *almost all acquisitions of properties of every size that have been made by large companies*" (p. 59, emphasis added). However, even its dairy merger statistics on large companies in Chapter III are quite incomplete. Worksheets for Chapter III were not made public, but it does list the companies making 10 or more acquisitions between Jan. 1, 1951 and July 31, 1954 (p. 57). Only two dairies are listed. It reported Borden and Foremost as making 10 and 43 acquisitions respectively. According to my records, during this period they made at least 27 and 50 respectively. And whereas Arden, Beatrice, Carnation and National did not appear on the FTC list, according to my records they made at least 14, 33, 14 and 13 respectively.

were reported as making 93 acquisitions, in fact, made at least 285. Except for Foremost, the financial manuals failed to report even half of the mergers of these companies. And in some cases they reported practically none. The outstanding example of this is Beatrice Foods Company. The FTC reported it as making only three acquisitions whereas in fact it made at least sixty-two. And the FTC completely omitted Pet Milk's seven acquisitions. Admittedly, most of these omitted acquisitions were small. But so were most of the dairy mergers recorded by the FTC.[7]

These omissions indicate that the financial manuals are a poor source of over-all dairy merger activity, even by large concerns. Moreover, the reliability of this source probably has changed over time. It is possible that some of the apparent difference in magnitude between the recent merger movement and that of the 1920's may be due to this shortcoming. Firms may have been less hesitant about publicizing their mergers in the twenties than they are today.

The second obvious inference we can draw from these findings is that small and moderately sized dairies, rather than large ones, did most of the merging. Whereas the four companies with assets in 1954 of more than $100 million accounted for about 80 per cent of the FTC's mergers, they represented less than 20 per cent of those reported here. And whereas the five other medium-sized dairies on the FTC list acquired only 20 per cent as many as the four largest, according to my records they acquired about 50 per cent as many. Finally, whereas the FTC listed cooperatives and other small dairy concerns as acquiring only three concerns, a more complete recording indicates that they made at least 764,[8] or about 70 per cent of all dairy mergers.

Just how important in the aggregate were acquisitions by moderate and small dairies to industrial structure? Unfortunately, we cannot give a precise answer to this question; but available information does give us some meaningful clues.

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[7] Only 4 of its recorded mergers were known to have assets exceeding $1 million; 27 had assets of less than $1 million, and 66 had assets of an unknown amount. Probably a fair amount of the latter were also $1 million or more, but the majority likely were less than $1 million.

[8] Even this figure very likely greatly understates the total *number* of mergers in this industry during 1948-54. There has been a drastic decline in the number of milk dealers in recent years. For example, between 1950 and 1956 the number of milk dealers in fourteen selected dairy states dropped from 15,556 to 12,462. (Stewart Johnson, "Dairy Marketing," Connecticut Agricultural Extension Service, Storrs, Connecticut, October 1956, p. 1.) Many of these disappearances very likely involved farmer-distributors, many of whom probably sold their routes to going concerns. However, few such transactions are reported in the dairy journals, and in this study I have excluded those which were. The number of such very small mergers during 1948-54 probably ran into the hundreds, perhaps thousands. But even the aggregate they probably did not affect significantly the structure of the dairy industry in terms of average firm size or market concentration.

Mergers by Medium-Sized Dairies

Let us look first at mergers by medium-sized dairies, i.e., those with assets between $10 million and $75 million. It is well to recall that at the outset of the current merger wave, Foremost Dairies, Inc., was one of the smallest of these. At the end of 1948[9] it had assets of only $11 million and sales of $33 million. Six years and more than 80 acquisitions later, its assets had grown to $125 million and its sales to an annual rate of $354 million. Its three largest acquisitions alone had total assets of $46 million when purchased. Certainly here the relation between mergers and rapid growth is quite obvious.

The other medium-sized firm probably growing most by merger during 1948-54 was Beatrice Foods Company. Between 1948 and 1954 its assets grew from $39.4 million to $69.1 million. Its absorption of 62 concerns played a prominent role in this rapid growth. Its largest acquired company alone has assets of $17.5 million.

Although Arden Farms did not make as many acquisitions as Foremost and Beatrice, its sixteen acquisitions may also have played a prominent part in doubling its size during 1948-54.

Although not obvious from its aggregate sales which increased by only 2.9 per cent, perhaps the dairy growth record of City Products Corporation was the most spectacular among the other firms listed in Table 1. Until 1948, when it acquired Midwest Dairy Products Corporation, City Products was in the ice and fuel business. In 1949, it acquired Frank Pilley & Sons, Inc., Sioux City, "one of the largest dairy and poultry businesses in Iowa."[10] In 1950 it acquired Jersey Gold Dairies, Shreveport, Louisiana, "one of the largest independent businesses in the South."[11] By 1954, after making five more acquisitions, City Products was operating dairies in eleven midwestern and southern states. This is indeed a remarkable growth accomplishment for a firm entering the dairy industry only six years before.

Fairmont Foods Company, like City Products, greatly expanded its dairy business at a time when its other lines were actually declining. For the past decade, Fairmont has been gradually shifting from its old line of eggs, poultry, and butter into more profitable lines—milk products and ice cream.[12] It greatly accelerated this move during 1953-54, when it

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[9] I have used 1948 instead of 1947 as the base year in measuring these firms' growth because they made very few mergers during 1948. Therefore, growth in 1948 was due almost entirely to nonmerger reasons.

[10] *Milk Dealer*, September 1949, 138.

[11] *Ibid*, June 1950, 109.

[12] *Wall Street Journal*, June 6, 1956, 21. During this time it discontinued all its own poultry-and-feed-processing operations.

acquired seven dairies, several of which were quite large.[13] By 1954, aided greatly by these mergers, 50 per cent of Fairmont's sales were in dairy products. Six more acquisitions in 1955 helped to bring its dairy sales to 60 per cent of total sales.

Abbotts Dairies acquired at least four dairies during 1948-54. The effect of these acquisitions on its growth is unknown. Although information on its sales growth is not available, its assets grew at about the same rate as the average of the three industry leaders in 1948—National, Borden, and Carnation.

Pet Milk Company made at least seven acquisitions during 1948-54; but apparently its dairy sales grew less than those of any other dairy in Table 1. Pet's relatively slow growth is explained partly by the fact that most of its sales are made in a declining part of the dairy industry. National consumption of evaporated and condensed milk, the bulk of Pet's sales, actually declined about 20 per cent between 1948 and 1954; but Pet's seven acquisitions probably helped it expand its share of the generally declining market in which it operates.

Swift and Company, the country's largest meat packer, experienced declining total sales during 1948-54. Although no information is available on its dairy sales, its six dairy acquisitions probably helped its dairy division to grow at a time its over-all sales were decreasing.

What significant inferences can we draw from the above facts? Unfortunately, our information is too rough to permit precise quantitative answers. This much, however, seems clear. Dairy sales of all but one of the seven smallest firms in Table 1 grew as rapidly as those of the three 1948 industry leaders, or more so. Further, the more rapid growth rate of several of these firms seems to have been aided greatly by their acquisitions.

We cannot say what mergers by medium and large dairies did to industrial structure, but we can say what they did not do. They did not increase concentration among the largest dairies. Comparisons of either the sales or assets of the eight largest dairies in 1948 and 1954 reveal these facts:

(1) In 1948, the sales of the country's top two dairies[14] comprised 64.0

[13] At least three of these were quite important. North American Creameries, Inc., Minneapolis, had assets of $4 million. *Corporate and Bank Mergers, op. cit.* p. 54. Peerless Milk Products Co., Rock Island, Ill., was "one of the largest dairy products companies in Davenport, Iowa, Rock Island, Moline and East Moline, Illinois areas." It also did a large business in western and south-eastern Iowa. *Dairy Record,* January 5, 1955, 16. Quinby Dairy, Inc., Hamburg, New York, has 6,000 customers and 45 workers. *Ibid.,* October 6, 1954, 8.

[14] The comparisons made here exaggerate somewhat Borden's and National's share of dairy sales because they sell a larger amount of nondairy products than the other top dairies. Moreover, some of their most important mergers during 1948-54 were non-

per cent of the total sales of the top eight dairies. By 1954 their share of such sales had dropped to 58.1 per cent. (Table 2) During the same period, their assets dropped from 68.2 per cent of the total assets of the top eight dairies to 62.5 per cent.

(2) Similarly, the sales of the four largest dairies in 1948 comprised 81.8 per cent of the total sales of the top eight dairies. By 1954 their share had

TABLE 2. CHANGE IN MARKET CONCENTRATION AMONG THE EIGHT LARGEST DAIRIES AND COMPARISONS OF THE SALES OF THE EIGHT LARGEST DAIRIES WITH TOTAL RETAIL SALES OF ALL DAIRY PRODUCTS

	1948			1954		
	Sales (000)	Per cent of eight dairies	Per cent of retail sales[d]	Sales	Per cent of eight dairies	Per cent of retail sales
Sales of top two dairies[a]	$1,636.0	64.0	22.5	$1,956.8	58.1	21.8
Sales of top four dairies[b]	2,088.9	81.8	28.8	2,620.4	77.9	29.2
Sales of four other dairies[c]	465.9	18.2	6.4	743.9	22.1	8.3
Sales of eight largest dairies	2,554.8	100.0	35.2	3,364.3	100.0	37.5
Retail value of all dairy Products[d]	7,265.0			8,980.4		

[a] National and Borden both years.
[b] Includes National, Borden and Carnation both years plus Beatrice in 1948 and Foremost in 1954.
[c] Includes Arden, Pet and Fairmont both years plus Golden State in 1948 and Beatrice in 1954.
[d] Estimated by dividing total farm cash receipts from dairy products by farmers' share of the retail value of all dairy products.

dropped to 77.9 per cent. Over the same period the assets of the four largest dairies dropped from 84.5 per cent to 82.3 per cent of the eight largest.

Although the evidence does not warrant the inference that this significant, though small, deconcentration within the top eight concerns was due to the relatively more extensive use of mergers by medium-sized firms, I personally believe this to be the case.

How about the top companies' share of *all* dairy sales? Was there any deconcentration in this respect? Estimates on this score are difficult to make because data are unavailable on the dairy sales of all processors. However, we can roughly gauge the direction of such concentration by comparing sales of the largest companies with the *retail* value of all

dairies. In 1953 National acquired Vegetable Oil Products Company for $9 million. This probably accounted for as much as 10 per cent of National's sales growth during 1948-54.

dairy products. Although distributive markups of some products changed more than others, comparing sales of large dairies with total retail sales should give us a clue as to whether large dairies' share of the market changed during 1948-54.

Such comparisons suggest that in 1954 the eight largest dairies sold a larger percentage of all dairy products than in 1948 (Table 2). In 1948 their sales were 35.2 per cent as great as total retail sales of all dairy products; in 1954 they were 37.5 per cent. Most of this increase went to the four smaller companies. In 1948 the smallest four of the top eight had sales 6.4 per cent as great as retail sales. The sales of their 1954 counterparts were 8.3 per cent as great as retail sales. Significantly, Borden's and National's sales were a slightly smaller percentage of retail dairy sales in 1954 than in 1948. On the other hand, the next two largest companies in 1954 apparently increased their share of total sales slightly over their counterparts in 1948.

Although these comparisons admittedly are rough, they suggest that concentration, when measured by the two largest companies, was about the same in 1954 as 1948, or down slightly. If we compare the sales of the top four companies, concentration was also about the same, or up slightly. If we compare the market share of the eight largest dairies, concentration seems to have increased somewhat during 1948-54.

What about the numerous mergers by smaller companies? Have they significantly affected the structure of the dairy industry?

Here our data are less accurate. Let us turn first to mergers that involved dairy cooperatives, on which our information is most complete.

Mergers Involving Dairy Cooperatives

Dairy cooperatives are concerns owned and controlled by their farmer-patrons. Today there are about 1,900 dairy cooperatives performing one or more functions in marketing dairy products valued at more than $2 billion. (Since some of these are only bargaining associations, mergers between them are not included in this study.)

Probably the chief competitive weakness of many dairy cooperatives is their relatively small size. Some have overcome this weakness by joining other small associations, forming jointly-owned sales federations. By pooling the efforts of many smaller dairies, some sales federations have enjoyed long, successful histories. Since about 1940, however, cooperatives increasingly have followed the merger routes—so heavily traveled by noncooperative dairies for about 30 years—in their drive for larger-scale operations. They have really followed two merger paths. On the one hand many cooperative associations have consolidated with one another; on the other they have acquired noncooperative concerns.

Between 1948 and 1954 many cooperatives continued—though at a declining pace—the movement begun during World War II of consolidating one cooperative with another. At least 69 dairy cooperatives merged in this way. The average merging cooperative during this period had annual sales of about $500,000.[15] So, in the aggregate, merging dairy cooperatives had sales of about $35 million at the time they merged.

In addition to consolidations among dairy cooperatives, many cooperatives have grown by acquiring other dairies. In all, at least 155 noncooperatives were absorbed by cooperatives during this period.[16] Most of these acquisitions were small, but a few were relatively large. At least four of these acquired dairies had annual sales near $10 million. Available information suggests that on the average the remaining acquisitions involved small concerns having assets of about $100,000 and sales of $300,000. Thus, in the aggregate, dairy cooperatives acquired cooperatives and noncooperatives with combined annual sales of more than $100 million.

Of course, this potentially larger volume was not distributed evenly among all cooperatives. It varied with the number and size of the acquiring firm's acquisitions. As shown in Table 3, 125 cooperatives made the 224 cooperative and noncooperative acquisitions recorded here. Eighty-nine (71.2 per cent) acquired only one concern, sixteen (12.8 per cent) acquired two, eighteen (14.4 per cent) acquired from three to seven, and two acquired eleven to fifteen. Although these acquisitions alone obviously could not have created many moderately sized cooperatives, they did play an important role in the growth of some associations. Ten cooperatives with sales exceeding $10 million in 1954 accounted for about one-fourth (58) of these recorded acquisitions. Several cooperatives owe much of their direct growth during this period to these mergers. And if this trend continues, we may soon have a number of medium-sized dairy cooperatives.

Mergers Among Small Noncooperatives

Let us turn finally to the 540 other mergers recorded here. As shown in Table 3 they were acquired by 455 firms. The great bulk of both the acquired and acquiring firms were small, with assets of less than $1

[15] Based on the findings of a study presently underway by the author on the importance of mergers in the growth of agricultural cooperatives.

[16] The FTC report included only one of these, the acquisition of Alpine Dairy by Consolidated Dairy Products Company, Seattle, Washington (*Interim Report, op. cit.*, p. 53). It included no consolidations among cooperatives. Both of these types of consolidations fell within the definition of mergers included in its Chapter II which recorded "going firms irespective of their legal form of organization, and by purchase syndicates." *Corporate and Bank Mergers, op. cit.*, p. 5.

million. About 90 per cent of the acquiring dairies made only one recorded purchase. Consequently, these mergers did not result in the emergence of any large dairies. But a few medium-sized firms made multiple mergers.[17]

Swift & Co., although primarily a meat packer, made six dairy acquisitions. Bowman Dairy, a leading factor in the Chicago area, made five acquisitions. Hood & Sons, Boston, operating plant and distribution outlets throughout most of the New England States, acquired four dairies. Bancroft Dairy, operating in Wisconsin and Michigan, also acquired five concerns. Another dairy, Superior Dairies, Inc., Saginaw, Michigan, was formed through the merger of five dairies. It was formed in 1949 by the consolidation of "four medium-sized Saginaw dairies." And in 1950 it acquired a fifth. In 1950 Jersey Gold Creamery, El Dorado, Arkansas, was formed by the consolidation of five Arkansas dairies.

Ten other dairies made three recorded mergers each. And forty-three acquired two others. About one-third of the latter involved the consolidation of three—usually local—dairies into a new company.

A rough, though perhaps conservative, estimate is that these more than 500 acquired dairies had aggregate sales of around $150 million. This assumes average annual sales per dairy of only $300,000. Several merging concerns are known to have made sales exceeding $1 million. Thus, during 1948-54, cooperatives and small noncooperatives acquired more than 700 dairies having aggregate sales near $300 million.

TABLE 3. DISTRIBUTION OF CONCERNS BY NUMBER OF ACQUISITIONS DURING 1948–1954*

	Total acquiring	Number of firms acquiring:									
		1 firm	2 firms	3 firms	4 firms	5 firms	6–10 firms	11–15 firms	16–25 firms	26–50 firms	50— firms
Ten dairies in Table 1	10	0	0	0	1	0	3	1	2	0	3
Dairy coops	125	89	16	7	4	3	4	2	0	0	0
All others	455	396	43	10	3	2	1	0	0	0	0
All dairies	590	485	59	17	8	5	8	3	2	0	3

* Includes acquisitions of acquired companies among those of the ultimate acquirer's.

Results of Mergers by Small Dairies

The net effect of these numerous small mergers on industrial structure is not clear. Their immediate effect doubtless has been to increase the degree of concentration in some markets. In truth, they may have contributed more to market concentration in particular geographic areas

[17] Bowman, and Hood & Sons might properly be classified with the medium-sized firms discussed above. However, neither is listed in the financial manuals.

than acquisitions by larger concerns. Acquisitions by the latter often were in new market areas. Foremost's most important acquisitions were of this type. However, mergers by small cooperatives and noncooperatives usually involved dairies already in the acquirer's market area. Thus they increased market concentration.

Of course, these mergers also may have significantly affected industrial structure if they have laid the basis for additional medium-sized dairies. But the prospects for the emergence of many moderately sized firms from the ranks of the industry's small noncooperative concerns are not very good. If large firms are given free rein in the present merger race, they will probably acquire many of these concerns before they become much larger.

This was the fate of many small firms growing by mergers during the 1940-47 merger movement and the earlier years of the current movement. Firms acquired during 1948-54 by the ten dairies in Table 1 had themselves acquired at least 97 dairies between 1940 and the time they were acquired. For example, Golden State had acquired 14 dairies between 1940 and 1953 when it was acquired by Foremost. In all, companies subsequently acquired by Foremost had themselves acquired 42 others between 1940 and the time they merged with Foremost.

An interesting hypothesis suggested by this experience is that while in the short run many small firms are gaining on the large ones, in the long run few ever attain very large size. The casual observer of the industrial scene may always observe many small rivials gaining rapidly on the industry's leaders. And if he watches only part of the race he may infer that the large are losing ground to the small. But if he watches the race out, he may find that before the rapid runners complete enough laps to close the lead in the industrial race, they quit the contest by joining their larger rivals. Therefore, we have the paradox of many small firms always running faster than the leaders but never catching them.

Insofar as this is the ultimate destiny of small concerns growing by merger during 1948-54, the final effect of mergers by small firms on industrial structure is indefinite. It will depend in part on which of the moderate and large concerns do the acquiring. It may also depend on whether or not the FTC and the Department of Justice try, and legally are able, to prevent the largest firms from acquiring many additional rivals.

Temporal Structure of 1948-54 Dairy Merger Movement

Our more complete record of dairy mergers reveals another interesting characteristic of the 1948-54 dairy merger movement that is not apparent

from the FTC data. In Table 4 all mergers are recorded by the year in which they occurred. Total merger activity showed a noticeably upward trend between 1948 and 1954 (Column 4), being nearly 40 per cent greater in 1954 than in 1948. But this trend was not common to acquisitions by companies of all sizes. Acquisitions by the ten largest dairies increased seven-fold, while acquisitions by all other dairies held at a fairly constant level. Thus mergers by larger dairies during 1948-54 represented a rising wave atop an otherwise relatively calm but deep sea of mergers. The FTC measures only the wave, it does not sound the depth of the sea.

TABLE 4. COMPARISON OF TOTAL DIRECT ACQUISITIONS BY TEN LARGE DAIRIES WITH THOSE OF ALL OTHER DAIRIES, 1948–1954

Year	Total direct acquisitions by ten large dairies*	Total acquisitions by all others	Total acquisitions by all companies
(1)	(2)	(3)	(4)
1948	9	127	136
1949	24	102	126
1950	35	112	147
1951	31	113	144
1952	42	127	169
1953	43	109	152
1954	69	119	188
Total	253	809	1062

*These are the ten dairies listed in Table 1. The number of acquisitions listed here differs from that in Table 1. The latter includes acquisitions made by acquired concerns between 1948-54 among the acquisitions of the ultimate acquirer. This table does not.

Conclusions

In summary, the above discussion warrants the following conclusions:

First, the FTC's recorded mergers represent less than 10 per cent of all mergers in the dairy industry. Even its merger statistics on the largest dairies are very incomplete. The FTC recorded less than one-third of them.

Second, the implication of the FTC's statistics that three large firms—Foremost, Borden, and National—did practically all the merging, is clearly contradicted by the evidence presented here. Mergers seem to have played an extremely important role in the growth of most medium-sized dairies as well. And not only were mergers even more numerous among small dairies, but in the aggregate they probably had an important impact on industrial structure. The facts clearly indicate that mergers among small concerns is commonplace in the dairy industry.

Third, the immediate result of mergers by small dairies probably was to accelerate their growth. But past experience suggests that before

many of these currently rapid growers become much larger, they in turn may be absorbed by the industry's larger firms.

Finally, annual mergers by small dairies ran at about the same pace over the entire 1948-54 movement. The increase in the over-all merger pace was caused primarily by the quickening pace of the industry's leaders. Thus, the FTC's study, which is based almost entirely on mergers by large firms, gives a biased picture of the temporal structure of this movement. Therefore, it is questionable that the FTC's statistics meet its hope that "at any rate the records are probably correct as to trend."

Does this study permit any generalizations as to the over-all accuracy of the FTC's report? Probably not. But clearly it does suggest that the errors of omission forced on the FTC by limitations in its basic data may lead to serious misinterpretations of the impact of merger activity on industrial structure in some important industries.

These comments should not be interpreted as an indictment of the FTC report. On the contrary, the FTC should be commended for completing a competent piece of work in only four months. It apparently made the most of the data at hand. And its limited staff could not be expected to do more.

NOTES

TELEPHONE INTERVIEW AS A MEANS OF SURVEYING FARMERS*

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RESEARCH agencies, particularly commercial consumer research groups, have quite successfully used the telephone interview for securing research data from urban populations. Baumer and Mitchell of Ohio State University used such a technique successfully for securing consumer information on milk consumption. However, they did pick up a consumer reaction that "We are glad to give this information to the University, but we are tired of these commercial outfits calling us."

The telephone interview has merit for securing certain types of research data from rural populations. Also, since it has not been used extensively with rural people, interviewee resistance should be no problem.

The efficacy of this method was recently tested in securing data from dairy farmers. The survey was a follow-up interview to supplement a previous personal interview with these farmers concerning their price and production expectations. These farmers had been contacted by personal interview to get their price and production expectations for selected image dates.[1] Then to check actual production responses as of these image dates, the telephone survey was conducted.

At the time of the original personal interview each producer was informed that such a telephone contact would be made at the given image date (six months later). He was asked to supply the interviewer with his telephone number and the time of day that would be most suitable for making the call. Also, each producer was given a chance to indicate whether or not he had any definite objections to this type of future contact. Only three of the total sample of ninety-seven refused to be called for further questioning.

Answers to twelve relatively short questions were obtained. These questions involved such information as the actual number of cows being milked, why this number varied from that which was previously expected for this image date, and whether the producer had altered his expectations from the previous interview regarding still future image dates.

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* Purdue University Journal Paper Number 1039, approved for publication October 12, 1956.

[1] The over-all research methodology was much the same as used by Willard F. Williams, "An Empirical Study of Price Expectations and Production Plans," *Journal of Farm Economics*, Vol. 35, No. 3, August 1953.

These questions were closely allied to the previous questions asked in the personal interview six months before.

Each producer seemed eager to answer the questions and many seemed to have been anticipating the telephone call even though the six months interval had passed since they were visited. Little if any explanation was needed to reacquaint the interviewee with the nature of the questionnaire and his answers were usually clear and concise.

The sample included ninety-seven farmers in eighteen counties in Northeastern Indiana with three producers just outside the state in Ohio and one in Michigan. Several farmers in this area are of Amish faith; thus, sixteen producers had no telephones. With three refusals this meant that seventy-eight producers were contacted by telephone. Seventy-two of these were called from Fort Wayne, approximate center of the area, in a three-day period by one person using two telephones. Some calls were placed between 11:00 a.m. and 1:00 p.m. with the majority made after 6:00 p.m. Thus, some other work was possible during these days. Six telephones were out of order due to an ice storm during the phoning period. These six producers were called from Lafayette, Indiana with equally successful results, but slightly higher costs. The entire telephone cost for the seventy-eight interviews was $29.45, or 38 cents per interview. One trip from Lafayette to Ft. Wayne to make the calls was necessary.

The producers who were not contacted by telephone were contacted by mail survey. Direct comparison of the success of the two survey techniques cannot be made from the results obtained here alone. Yet, some comparisons seem justified. After as many as three follow-up letters, the mail survey was only 82 percent complete. Also, the information furnished by mail was not as complete nor did it appear as accurate as that secured by telephone. Also, timeliness of data collection with the telephone technique can be a big advantage. Analysis often cannot be started until the last schedule is in, and with mail techniques this may be considerably after the survey is started.

It was felt that any small additional cost for the telephone survey would justify its use on this type of data collection, even though it might be possible to get a high rate of returned survey forms by mail. As questions become more detailed and explanation of the questions becomes desirable, the telephone survey has added merit. There would be a limit to the amount of data that could be secured by telephone, but it seems to be considerably in excess of the answers to the twelve questions asked here. Especially, if the different subject-matter areas of questioning are restricted, it seems quite easy to get good data.

The fact that personal contact had been made with the farmer prior

to the telephone call was thought to be quite important in the success of this particular survey. On the other hand, such prior contact is not imperative for the success of the method.

All in all, even under quite unfavorable circumstances, the telephone survey gave promising results for surveying rural residents. In this study, it seemed to be more satisfactory than the mail survey and of very little, if any, additional cost. Certainly, it was much less expensive than a personal interview would have been. For example, the mileage traveled to secure the data on the personal interviews in this study averaged 45 miles per usable schedule. Also, interviewer time was much greater.

THE COST OF HUMAN ENERGY IN AGRICULTURE

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COST accounts have long been an integral part of industrial economics. In agriculture, however, some believe that concrete calculations of production costs are not possible. On farms it is more difficult to obtain the necessary data and there is less relevant knowledge, experience and technical equipment than in the manufacturing industry. In the latter, extensive and detailed accounts are usually kept. Further, the great differences in the natural, economic and other productive conditions hamper the framing of general rules for agricultural cost accounts. Unforeseen plant and livestock diseases and unfavorable weather conditions may cause great fluctations in costs and returns.

We shall here deal only with the cost of human labour. According to Heuser the cost of human labour average 57 per cent of the total costs. This high percentage justifies an analysis of labour costs, even though it is often difficult on account of the structure of the family holding. Cost studies have shown, that the cost of human labour is about 40 per cent of the total costs, while Woermann states 50 per cent, for wages and costs of equipment. Reliable data are not yet available as to what part the cost of human energy is of the total cost of human labour. We may well ask: From where does the required energy come and can the cost be calculated?

The energy used in bodily labour is derived from the energy supplied to the body in the form of food. For this purpose the human body converts chemical energy into mechanical energy. Man has not only to convert energy, but also to produce a specified sort of labour. So the limiting factor of every type of labour is constituted by the amount of energy

supplied with the food. Such dependence on the input and output of energy is evident for engines. For man, however, things are different. When he does not immediately use the amount of energy received, he may store it in the shape of reserve substances. Further, the reserve substances may be used when the energy received is less than the energy delivered. Therefore, there need not be a correlation between the energy received and the labour product for a single day. (This will appear in the long run. The energy used during leisure periods should be taken into account.)

Even in bodily rest there is a consumption of energy in the organism (because there is a constant production of labour). This basic consumption averages for a grown man about 1500 Calories a day. In addition, the digestion of food requires energy according to the sort and quantity of food taken in. This energy requirement varies between 5-10 per cent of the total number of calories of the food consumed and depends mainly on the protein content of the food.

To perform labour greater amounts of energy are required. Even in rather light labour the muscles may consume 50 per cent of the total energy used by the body, and in heavy labour this percentage may rise to above 80. The energy requirement for the various sorts of labor is:

for light labour	up to 75 Calories/hour
for medium heavy labour	75–150 Calories/hour
for heavy labour	150–300 Calories/hour
for very heavy labour	more than 300 Calories/hour

The amount of energy actually used will this be in excess of the amount required for basic metabolism, the digestion of the food and movement. This later amount is about 2200 Calories per man per day. As energy for labour and other energy are both derived from food, they cannot be separated. Therefore, the costs of these two groups should be dealt with simultaneously.

The cost of human energy may be important in economic research when manual labour is a considerable factor. The cost of human energy should also be compared with that of machine power and machine used.

In addition, in the costings of mechanized labour occur such items as interest and depreciation of engines, which are entirely or nearly entirely absent in manual labour costings.

Taking only technical costs into account may often lead to wrong conclusions because more bodily labour entails a greater consumption of energy and, consequently, higher financial expenditure for the requisite food. So the cost of human labour must be included in such calculations.

But the cost of human energy for farm labour is hard to calculate. The agricultural population use widely-diverging food habits. This has been

shown by a series of studies of the nutrion of farm populations, that they provide evidence of the range of costs for labour (Table 1). The various diets are not only of nutritional but also of economic interest in energy.

Costs should include all arts necessary for adequate nutrition. Nutrition is adequate, when all nutrients known to be required (protein, fat, carbohydrates, vitamins and minerals) are present in sufficient amounts and when health and ability to work are ensured in each occupation. The amount of foodstuffs of nutrients required for the various occupations or operations depends on the heaviness of the work in question. In the many-sided farm work we can hardly speak of 2 specified food requirement. The greater part of the farm workers is not charged with a special task that they do day by day. Most of them have varied occupations in which the various parts of the body are used alternately. They have to do all sorts of labour, both light and heavy labour, in every season and in all weather conditions. Consequently the energy requirement changes enormously in the course of a year. During the harvest and also in other peak periods of labour, e.g. in spring, farm labour is among the heaviest labour in all industries. On the other hand, the energy requirement is far

TABLE 1

(The results are partly of research of earlier data.)

	Nutrient value and nutritional value of				
	Protein (grs.)	Fat (grs.)	Carbohydr. (grs.)	Calories (kcal)	Remarks
Farm labourers in South Sweden	134	80	520	3,440	
English farm labourers	95	49	517	2,955	
Farm labourers in Ireland	92	42	518	2,890	
Farm labourers in Scotland	142	59	640	3,755	
Farm labourers in Wales	126	57	653	3,725	
Rural population in the area round Moscow (poorer)	129	33	589	3,250	little fat, protein from bread more than 60% of total proteins
Farmers of the province Venice	117	64	619	3,610	maize and beans
Farmers of the province Emilia	82	63	580	3,300	
Farmers of the province of Umbria	75	27	670	3,305	
Rural population of the Abruzzi	123	62	250	2,100	chestnuts and acorns
Finnish rural population	117	104	686	4,810	
Japanese farmers	69	20	418	2,170	almost vegetarian
Farmers in Chile	96	61	580	3,340	
Farmers in USA	108	136	493	3,570	
Farm labourers of Siebenburg (during harvest)	182	93	968	5,580	maize, meal and beans
French farmers	153	47	693	3,900	
French farm labourers Dp. Corrèze (harvest)	164	68	1,040	5,560	
Spanish farm labourers Valencia (harvest)	180	40	800	4,390	
Dutch farm labourers from Zaandam	92	126	425	3,290	
Dutch farm labourers of the province of Groningen	99	154	401	3,480	
Farmers' families Eastern Germany	70–120			3,790	
Farm labourers (harvest) of Pommern	125			4,550	
Rural population in the Bavarian Ober Pfalth	100	65	712	3,900	
Students (harvest), Bavaria	123	123	445	3,680	
Farm labourers (harvest), Bavaria	185	180	645	5,170	
Farmers' families near Berlin	122	140	513	4,080	
30 farmers' families in Germany	106	140	500	3,780	
85 farmers' families in Württemberg	100	116	492	3,510	
3 farms in Weser Ems	84	89	487	3,170	

smaller in other periods. It should be further taken into account that the requirements of bodily labour will mainly depend on the farm size, the cropping plan, soil conditions and degree of mechanization. It is, for instance, possible that of two farms with equal productive conditions and equal standard of life, one will require only half as much energy for labour as the other because it is more mechanized. (This means that it also has only half of the cost of human energy.)

The diet on which costs are based should provide for average energy requirements. After various investigations we have calculated an average, which amounts to 3,400 Calories, for West German agriculture. This high number of labour Calories is needed because in German agriculture much heavy work is still done. These 3,400 Calories can be derived from 100 grammes of protein, 100 grs. of fat and 500 grs. of carbohydrates corresponding with the estimates of H. Kraut for self-suppliers during the rationing period.

From inquiry the families of small farmers it appears that the economically weak farms are those that have an inclination to grow a large part of their own foodstuffs. Nutrition is somewhat neglected and they often refrain from buying foodstuffs, either for lack of money or lack of purchasing possibilities. It is for instance difficult regularly to obtain fresh fish in many places that are situated far from the water.

In the calculation of the cost of human energy account should be taken of the retail prices of foodstuffs. E. Dulon found in 1937 that on 16 farms lying scattered all over Germany the diets of the farm family consisted 60 per cent of farm-grown products, and 40 per cent of purchased foodstuffs. There are, however, also farms that derived 80 per cent of the calories consumed from their own production and others only 30 per cent. The foodstuffs on the farm provided, on the average, 68 per cent of the total protein, 56 per cent of the fat and 58 per cent of the carbohydrates. The range on the various farms was for protein, from 45 to 90 per cent, for fat, from 43 to 76 per cent, and for carbohydrates, even from 15 to 87 per cent. These data show the great variation and the wide range of possibilities in practise with regard to foodstuffs consumed on farms. In any case, whether foodstuffs are home produced or bought, the nutrient requirements may be met with expensive or cheap foodstuffs, increasing or decreasing the household cost. We may view the running of the household in the light of cost and, consequently, of the cost of human energy.

Table 2 states the foodstuffs that, according to West-German conditions, may meet the average food requirement of the rural population. The foodstuffs listed contain 100 grs. of protein (including 40 grs. of animal protein), 100 grs. of fat and 500 grs. of carbohydrates, which works out at a total of 3,400 calories. The cost is calculated from growers

and retail dealers' prices, according to available estimates. For some foodstuffs average values were used, which were calculated from prices of various products. The cost of sugar, cheese and fish have been calculated from the retail prices. For all other products the costs of handling and processing, etc. are known up to the final point. The bread price calculated from these data includes the grower's price, baking cost, cost of milling losses and milling cost. The price thus obtained for 1,000 calories is about 40 Dpfg. without losses in the kitchen. When we put the loss in rural households at 10 per cent and assume that purchased foods provide 40 per cent the total calories, the cost of human energy in Agriculture is 50 Dpfg. per 1,000 calories, according to the prices ruling in the spring of 1955. If we compare this cost of energy with other fuel, which serves for the supply of energy, it appears that the energy of foodstuffs is the most expensive by far, for 1,000 calories in the form of electric energy cost some 5 Dpfg. and in the form of coal only 0.5 Dpfg.

Also for the farmer it is important to compare the knowledge of the cost of human energy with other sources of mechanical energy. Yet also from another point of view it is necessary for him to pay attention to the amounts of human energy consumed on his farm, because he pays this energy himself in contrast with the manufacturing industry, where as the employee himself pays for his sources of energy. In agriculture the farmer is responsible for this. That is to say, as far as regular labourers are concerned, or in principle, those who are employed on the farm eat with the farmer. If the farmer is acquainted with the cost of human energy and makes a choice of foodstuffs according to the calorie price advantage, this would be nutritional physiologically unjustified, for then only the foodstuffs rich in calories would be served. Ohlmüller relates that at the turn of the century the daily fare of Siebenburg farm labourers in harvest time consisted only of maize meal, garden beans and salt. Adequate nutrition is essential to maintain labour capacity. The farmer, on the other hand has an opportunity of replacing, to a certain extent, the amount of expensive human energy by other, cheaper energy. He can do this by applying technical means. According to Medici too much heavy labour and malnutrition are two pathological characteristics of many European small-holdings. Investigations into the living conditions of workers show that some workers had more than 4,000 labour hours, some women had as much as 4,450 hours. Assuming that an average farm worker works 3,000 hours a year, we find the following cost according to the heaviness of the work: for light work with a calorie consumption of 50 calories/hour = 75 Deutsche Mark (DM) for medium heavy labour with 100 calories/hour = 150 DM, for heavy labour with 150 calories/hour = 225 DM, with 200 calories/hour = 300 DM and for very heavy labour with 300 calories/hour = 450 DM.

TABLE 2. COST OF HUMAN ENERGY

Foodstuff	Quantity		At retail prices	
	Per day (grs.)	Per Year (kgs.)	Price per 100 kgs. (DM)	Cost per year (DM)
Bread	550	182.5	55.00	100.38
Victuals	50	18.3	73.00	13.36
Pulses	10	3.7	90.00	3.33
Sugar	55	20.1	136.00	27.34
Potatoes	750	273.8	7.50	20.54
Vegetables	150	54.8	25.80	14.14
Fruit	100	36.5	60.00	21.90
Fat	50	18.3	302.00	55.27
Meat	110	40.2	327.00	131.45
Whole milk	500	182.5	27.00	49.28
Cheese	20	7.3	400.00	29.20
Eggs	20	7.3	315.00	23.00
Fish	10	3.7	180.00	6.66
Total (per head per year)				495.85
Per head per day				1.36
1,000 Calories				0.40
Nutritions per head per day:				
protein	100 grs.			
of which animal	40 grs.			
fat	100 grs.			
carbohydrates	500 grs.			
Calories	3,400			

DM = Deutsche Mark

Also researches on special labour showed differences in cost. Labour physiological researches of agricultural operations made by our institute showed the difference in human energy consumption in ploughing with 1-furrow horse-drawn plough and a 1-furrow tractor-drawn plough. For a parcel of 1 ha. (200 × 50 m.) we found an energy consumption of 3,600 calories in ploughing 1 ha with a 1-furrow horse-drawn plough and 1,100 calories in ploughing 1 ha. with a 1-furrow tractor-drawn plough. Consequently, the cost of human energy is 1.80 DM in ploughing 1 ha. with a 1-furrow horse-drawn plough and 0.55 DM with a 1-furrow tractor-drawn plough. Another example shows the saving of human energy and its cost in mechanical milking as compared with hand milking. We found that the cost of human energy in mechanical milking 1.25 DM and in hand milking 1.80 DM per 1,000 kgs. of milk, so that 0.55 DM per 1,000 kgs. are available for interest and depreciation of a milking machine.

By strewing fertilizer 1 ha. by hand the cost of human energy is 0.55 DM (1,100 calories), in strewing fertilizer 1 ha. with a tractor-drawn strewing machine, the cost is 0.07 DM (130 calories). The cost relation in human energy between real going and all tractor-drawn works, when the

worker sits down on the tractor, is 3-5:1. Similar are the results between digging a garden with a spade and a fraise, reaping by scythe and reaping by reaping machine, picking potatoes by hand and by machine or cleaning wood by axe and by wood-breaking-up machine.

Energetic and economic aspects justify the desire of transferring wherever possible human labour in agriculture to other sources of mechanical energy and liberating man for achievements on a higher level.

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NOTE ON THE IMPLEMENTATION OF WATER POLICY

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IN HIS discussion of the need for foresight in water policy formulation, Edward Ackerman has touched on the major role played by special-interest groups to date.[1] The social significance of this dominance is not the major purpose of the article, nor has it been analyzed elsewhere to my knowledge, for possible fundamental obstructions to the eclipse of special-interest control by the implementation of ". . . a clear, accepted, reasonably stable body of principles . . ."[2]

There are two features in the national personality which operate directly against elimination of special-interest influence by logically derived principles in fields such as water management. The nation prides itself on its spirit of competition. Furthermore there is a natural

* Chief Engineer of J. M. Lehmann Co. These observations are based on the author's personal and professional experience while an engineer for the Bureau of Reclamation in 1953-54.

[1] "Questions for Designers of Future Water Policy," *Journal of Farm Economics,* XXXVIII: 4 (Nov. 1956) 972-3.

[2] *Ibid.* p. 971.

tendency for an individual to exaggerate the national importance of groups closest to him. The competitive spirit nurtures divergent objectives and the natural social ego inflation exaggerates the difficulty of resolving conflicts on a logical basis such as that studied by the welfare economists. These economists are trying to place the determination of net social gain on some logical and generally accepted comparative evaluation of persons and groups.

The difficulties encountered by the welfare economists indicates the complexity of arriving at any logical solution to the conflicts and the need for long, specialized, expert study. These severe requirements should disqualify the average voter from direct participation in the analysis even though the solution affects his personal welfare so closely. Complexity also raises obstacles to demonstrating who the experts are or will be, particularly since the people to be convinced are supposed to be handicapped in their judgments of such matters. (This is also democracy's dilemma: how can laymen pick among experts?)

Furthermore delegation of critical responsibilities and confidences is accomplished better in traditional and stable environments. Yet, ironically, this condition is upset somewhat by the reform and its antecedents.

A controversy between the California-Oregon Power Company (Copco) and the U.S. Bureau of Reclamation is an illustrative case. Both parties have plans for a storage dam near the California-Oregon border on the Upper Klamath River. The primary purpose of the Bureau's dam would be irrigation; Copco's plans are primarily for power.

The Bureau is seeking support from those traditionally favoring farming as a way of life and those weary of big utility company control. Copco seeks its adherents from those supporting free enterprize and local control and the states. Relatively little attention has been given to the detailed reports made by either Copco or the Bureau so evaluation of the benefits and losses listed in these reports has been replaced by generalities.

I experienced considerable difficulty trying to explain the irrationality of decision by generalities and the need to resolve the divergent aims by more logical means. It was even harder convincing anyone that construction of suitable logical systems should be in the hands of impartial experts. My efforts may not be representative but the above arguments suggest that convincing people to delegate their trust to scientists is an underestimated and neglected problem. While the public is being alerted about the value of the physical sciences it is opportune to study and point out the dilemma of transferring public confidence from special interest groups to the social scientist.

HOW WILL THE SOIL BANK PROGRAM AFFECT COTTON PRODUCTION?

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WHAT does the road ahead hold for cotton and the cotton farmer? A subject of great interest today is the soil bank program and what its effects will be. Questions are being asked such as, "Will the farmers voluntarily decrease their crop acreage and if so, how will it affect total production?"

One of agriculture's great trouble spots has been and continues to be the declining markets for cotton. With more than twenty years of production controls behind us, demand and supplies of cotton continue to be unequal at favorable prices to the farmer. Cotton's problem is being attacked from both sides.

On the demand side of cotton, much is being done to find new uses, create new markets, and expand consumption generally. The supply side has also had its share of attention. Those familiar with previous legislation enacted to reduce cotton supplies, will remember how acreage decreased while yields per acre kept climbing to hold total supplies at a high level.

Although cotton acreage controls are presently in force, the new soil bank plan is attempting to reduce cotton acreage further by providing incentives for farmers to voluntarily reduce their acreage below the farm allotment.

The Soil Bank Program

The Soil Bank Act, which is one of six sections in the Agricultural Act of 1956, is supplementary to the acreage allotments and marketing quotas authorized under the Agricultural Adjustment Act of 1938.

Two separate programs are provided under the Soil Bank Act, the acreage reserve program and the conservation reserve program. Compliance under the Acreage Reserve Program requires the producer to reduce his cotton acreage below his farm acreage allotment or farm base acreage. There cannot be any harvest of crops or grazing on the reserve acreage and it must be kept reasonably free of noxious weeds. For the 1956 cotton crop, payments were determined by multiplying the base unit rate, which is 15 cents per pound, by the average yield on the farm. The maximum acreage per farm that may be placed in the soil bank is one-half the farm allotment, or ten acres, whichever is larger. The minimum is ten per cent of the allotment, or two acres, whichever is larger.

In addition to the acreage reserve program, a farmer can reduce his cotton acreage further by complying with the conservation reserve program. A contract covering from three to fifteen years is signed in which the farmer agrees to divert present cropland to grasses or trees. The farmer is paid about eighty per cent of the cost of establishing this vegetative cover in addition to a small annual payment for the use of the land. No harvests or grazing are permitted on this acreage.

Alternatives to Farmer

The farmer now has several alternatives. He may participate in either the acreage reserve program or conservation reserve program individually, or he may qualify for both programs at one time. Also, he may elect to continue planting his cotton allotment and not participate in the new program.

How will farmers make this decision? Aside from any long-range conservation and soil improvement benefits accruing through participation in the soil bank program, practical farmers will try to determine which program will provide the greatest net income. To constructively analyze all income possibilities, each farmer will need to know his costs of production.

It is a well known fact that the production costs vary from farm to farm and that many farmers do not have accurate cost records on their farms. However, studies have been made to secure useful cost data for the major areas of cotton production. Table 1 shows estimated average production costs and net income for two levels of mechanization in three groups of production areas.

TABLE 1. ESTIMATED AVERAGE PRODUCTION COSTS AND NET INCOME PER POUND FOR TWO LEVELS OF MECHANIZATION IN THREE GROUPS OF COTTON PRODUCTION AREAS*

Production Areas	Cost Per Pound	Net Income Pound
	(Cents)	(Cents)
Tractor power and machine harvest:		
High Plains, Delta, Irrigated West	20	12.4
Southwestern cotton areas	24	8.4
Southeastern cotton areas	26	6.4
Tractor power and hand harvest:		
High Plains, Delta, Irrigated West	23	9.4
Southwestern cotton areas	26	6.4
Southeastern cotton areas	27	5.4

* Average price received by farmers for cotton sold from August 1, 1955 through April 1956 was 32.4 cents per pound.

Figures are for the 1955 crop year. All costs are included with the exception of wages for the operator's labor and management.

The spread between selling price and cost of production gradually lessens with the greatest difference being on farms with tractor power and machine harvest. In both levels of mechanization, the High Plains, Delta, and Irrigated West had the greatest net.

Cotton production is rapidly shifting to complete mechanization. The percentage of growers in all areas using animal power and hand harvest declined from 36 to 13 during the years 1947 to 1954.[1] During the same period, the percentage of growers using tractor power and machine harvest increased from 3 to 20. Cotton farms using animal power appear to be mechanizing or shifting out of cotton production.

Possible Effects of Acreage Reserve Program

A fair appraisal of the acreage reserve program cannot be made from results obtained on the 1956 cotton crop. The law was enacted after planting time in some areas and many farmers were reluctant to destroy part of the crop. Expenses of planting and destruction had to be considered in reaching a decision. Also, parts of the Cotton Belt were affected by an extended drouth, which could possibly have caused some farmers to participate in the program who normally would not do so.

For the 1956 crop, cotton farmers placed about 1,064,000 acres in the acreage reserve program. This was six per cent of the acreage alloted for cotton production.

For the 1957 crop year, cotton producers will likely weigh the income possibilities from the acreage reserve against actual production of cotton before reaching a final decision.

Table 2 compares the estimated incomes from the two plans. Average yields per acre are used for the different producing areas. The individual farmer would substitute his farm yield for this average yield in making his calculations. Results here indicate a higher net income is available from the acreage reserve program in all areas of production and levels of mechanization. The least gain is found in the High Plains, Delta, and Irrigated West.

Possible Effects of Conservation Reserve Program

The conservation reserve program will have its greatest appeal to farmers who are conservation minded. The largest benefits must be expected in future years under this program.

It is difficult at present to appraise the benefits to the individual farm. Present indications are that the farmer will receive about eighty per cent of the cost of establishing grass or trees plus an annual payment

[1] M. K. Horne, Jr., Frank A. McCord, and George Townsend, "Price and the Future of U. S. Cotton," National Cotton Council of America, Memphis, Tennessee.

of approximately ten dollars per acre during the term of his contract. Since the acreage cannot be harvested, this would be his total income from these acres. These annual payments would help the farmer recover his share of the costs in establishing the cover. The farmer would realize no income for the first two years and very little during the remaining years of his contract, or until he begins to harvest crops from the acreage.

TABLE 2. ESTIMATED INCOME PER ACRE FROM COTTON PRODUCTION, AND FROM ACREAGE RESERVE PROGRAM, TWO LEVELS OF MECHANIZATION, THREE PRODUCING AREAS

Production Areas	Average Yield per Acre	Continuing cotton Net Income		Acreage Reserve Payment—15¢ lb.	
		Pound	Acre	Gross	Net*
	(Pounds)	(Cents)	(Dollars)	(Dollars)	(Dollars)
Tractor power and machine harvest:					
High Plains, Delta, Irrigated West	494	12.4	61.26	74.10	69.10
Southwestern cotton areas	248	8.4	20.83	37.20	32.20
Southeastern cotton areas	314	6.4	20.10	47.10	42.10
Tractor power and hand harvest:					
High Plains, Delta, Irrigated West	494	9.4	46.44	74.10	69.10
Southwestern cotton areas	248	6.4	15.87	37.20	32.20
Southeastern cotton areas	314	5.4	16.96	47.10	42.10

* Net income allows for a charge of $5.00 per acre for keeping the land free of weeds under the acreage reserve program.

Effects of Soil Bank on Production

Will the soil bank program reduce cotton production enough to relieve the surplus problem? Production of cotton may or may not decline. Results of this study indicate that the westward movement of production may be accelerated through influence of this program. Since the greatest gains under the program are found in areas outside the High Plains, Delta, and Irrigated West, the program will likely be more acceptable in areas of lowest yields and least degree of mechanization. With yields per acre continuing to increase and production moving to lower-cost areas, total production of cotton could possibly rise. As contracts expire under the program, the acreage could return to producing cotton. Long-run effects may be higher yields and production than at present.

On the other hand, a decline in total cotton production may occur. Since only six per cent of the alloted cotton acreage was placed in the soil bank program in 1956, it is likely that participation will be greater in succeeding years. If production is reduced by twenty per cent in the Southeast, twenty per cent in the Southwest, and ten per cent in the High Plains, Delta, and Irrigated West, this would account for almost two and one-half million bales. At present consumption levels

and exports, several years would be needed to have much effect on present stocks of approximately 14 million bales.

It is likely that total cotton production will be reduced by the soil bank program for the next three to five years. After this period, unless the program is amended or acreage allotments reduced further, the surplus problem will likely become more acute than it is today.

COMMENTS ON "SEX AND BRAND-PREFERENCE"

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IN HICKS' note on "Sex and Brand-Preference" in this *Journal*,[1] the stated conclusions are based upon erroneous tests of significance and hence are without foundation. This is easily seen in his Table 2, "Location effect on and differences between male and female customers." This table shows that the percentage of men buying brand B when it was displayed so as to be usually reached first was 8% greater than when it was second, the corresponding difference for women being 23%, the respective values of t being given 1.11 and 3.37. As men and women respond in the same manner, t for the difference between sexes must be roughly the difference between the two t values divided by the square root of two. This would be about 1.60, but Hicks gives 4.22.

Reconstructing the actual frequencies underlying Table 2 gives

	Men		Women	
	Bought B	Bought A	Bought B	Bought A
B first	62	33	74	38
B second	50	38	42	56

The appropriate test for interaction in such a $2 \times 2 \times 2$ table is chi-square calculated by the method given by Bartlett.[2] Chi-square for Hicks' table is 2.056, so that t is 1.43, not enough for the 5% significance level. Hence, far from being "quite conclusive," these data provide no substantial basis for the conclusion that men and women differ.

Hicks' table 3, concerned with amounts purchased, is open to parallel criticism, giving t's of 0.16 and 3.09 for men and women respectively, and claiming 7.87(!) for t for the difference. Unfortunately the data given in the table are insufficient for calculating the correct value.

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[1] John W. Hicks, "Sex and Brand-Preference," *Journal of Farm Economics*, Vol. XXXVIII, No. 1, February 1956, pp. 179-182.

[2] M. S. Bartlett, "Contingency Table Interactions," *Supplement to the Journal of the Royal Statistical Society*, Vol. II, No. 2, 1935, pp. 248-252.

PRICING SUGAR BEETS IN BELGIUM

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SUGAR beet growers in Belgium are paid prices which are based on (1) the amount of refined sugar sold by processors on the domestic market and the average wholesale price; (2) the average world price paid for refined sugar and the amount exported by the processors; (3) the amount of sugar beets delivered to sugar processing plants under or above the quota;[a] and (4) the sugar content of the beets.

Each year, prior to the planting time, growers are instructed by the Sugar Committee relative the amount of beets they will be able to sell to the factory within the quota.[b] For the year 1954, the total quota had been fixed at 275,000 metric tons of sugar; 245,817 (89,39%) metric tons for local consumption; and 29,183 (10.61%) for export. The sugar beets which are needed to obtain this amount of sugar are considered to be "within the quota." In establishing sugar beet prices, the amount of sugar sold on the export market had to also be considered. The average price of the refined sugar delivered within the quota is determined as follows:

835.28 BF (average domestic price)	89.39% (percentage refined sugar sold on the domestic market within quota)	746.66 BF
497.49 BF (world price)	10.61% (percentage refined sugar exported within the quota)	52.78 BF
Average wholesale price of refined sugar, produced from beets delivered within the quota		799.44 BF

One BF (Belgian franc) = $.02

Furthermore, sugar beet prices depend also on the sugar content of the beets. For the 1954/55 sugar season, processors and growers agreed that for sugar beets of 15.5% sugar content, growers will receive 75% of the domestic price for refined sugar. When sugar quotations on the domestic market increase or decrease by portions of 40 BF, the base percentage

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[a] Delivery quotas are established for best producers on the basis of the amount of sugar needed for domestic use. Growers usually receive a much smaller payment on any beets they deliver in excess of this quota, since the price of sugar sold on the export market is lower.

[b] Members of the Sugar Committee represent growers, processing plants, the Ministry of Agriculture, and the Ministry of Economic Affairs.

(75%) will vary by 1% up or down. On the basis of the average price obtained for refined sugar during October 54/Aug. 55 (830.28 BF per 100 kgs.), the percentage to be used by beet processors in computing beet prices is determined as follows:

	840	BF = 75%
800 BF plus	40	BF = 74% plus 1%
800 BF plus	35.28	BF = 74% plus 1% times 35.28 over 40
	835.28	BF = 74.882%

Therefore:

1) Sugar beets with 15.5% sugar content delivered *within* the quota were paid at 799.4 BF times 74.882 equals 598.64 BF per metric ton.

2) Sugar beets with 15.5% sugar content delivered outside the quota were paid at 497.49 BF times 74.882 equals 372.53 BF per metric ton.

For each additional percent above 15.5% sugar content, prices were increased by 10%. For each additional percent below 15.5% sugar content, prices were decreased by 12%.

The actual prices received by growers are determined by the method herein described. Each year, a grower sugar beet committee and representatives of sugar processing plants sign a contract which definitely establishes the levels for production quotas, average domestic price, world price, base percentages, and other conditions relative to purchase and sale of raw sugar beets between growers and processors.

MEMBER BEHAVIOUR AND OPTIMAL PRICING IN MARKETING COOPERATIVES

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THE comments of Dr. Hans Ohm on my note in this *Journal* on "Economic Nature of the Cooperative Association," in my opinion, are based upon a series of misunderstandings.

My comments did not cover the question of pricing policy of the cooperatives at all. In my example from Norway the price was fixed by the government, but I did not treat the question of price formation. Ohm seems to be aware of that, but concludes that "we have to consider his statement as a new pricing theory" if it should be much more than a banality. Here he presents a very peculiar type of reasoning. However, surprisingly enough the same banality is the main theme of the rest of his own paper (from Chapter III). Ohm writes about "a revival of the famous controversy on the marginal-cost pricing principle of the thirties." I must confess that as a pupil of the professors Frisch and Haavelmo, that controversy is quite unknown to me. Ohm most likely must be

referring to a local controversy in prewar Germany. As long as it is taught in all modern elementary textbooks in economics it should not be necessary to use so much space as he has done proving that profit is maximized for a firm, and for a group of firms as well, by the so called marginal principle.

In Chapter III Ohm writes about the relevance of the marginal principle in cooperative associations in practice, the same theme as I treated in my note. I shall first correct some misunderstandings that occur in this connection also, and afterward give some principal comments on the problems.

The theoretical framework of Dr. Phillips involves: (1) the economic structure of the cooperative association, (2) the economic relationships among the participating units; and (3) the conditions for profit maximization in the cooperating firms.[1] We should note that Phillips's analysis of (3) (the conditions for profit maximization) is based upon (2) (the economic relationships among the participating units). Important here is that he assumes the proportionality *principle* for all economic functions, that for instance the cost and the economic benefits in connection with the joint activity are shared on the basis of proportionality. These assumptions are a part of Phillips's model. The statement in my note[2] will be correct for all the member firms under the assumption that they act as quantity adjusters. Ohm and I agree on this point. Ohm, however, does not start by stating assumptions regarding economic relationships among the participating units. On the contrary he states the conditions for profit maximization for a group of firms in general, and afterwards asks what norms of behavior and institutional arrangements lead to profit maximization. His approach is, therefore, quite different from the approach of Phillips. Ohm first finds the conditions and afterward asks if we can find operational principles so that they can be fulfilled. He finds the same results as I do, that under the operational principles stated by Phillips, the members will act in accordance with the average cost and the average return in the joint plant as quantity adjusters.

Concerning the frame of reference for an analysis of cooperation, we can first make a distinction between what *is* and what *ought to be*. Under the first heading we may differ between a purely descriptive treatment of cooperation and an analysis of the economic behaviour of the cooperative associations in practice. Under the given assumptions regarding cooperative principles and institutional arrangements, operational principles in-

[1] R. Phillips, "Economic Nature of the Cooperative Association," *Journal of Farm Economics*, February 1953, p. 74.

[2] O. Aresvik, "Comments on 'Economic Nature of the Cooperative Association,'" *Journal of Farm Economics*, February 1955, pp. 140-144.

clusive, we can ask what is the "best" economic behaviour. And we can compare this behaviour with the economic behaviour in practice.

Or we can ask what ought to be in a wide sense, gradually dropping the assumptions of the given institutional frame of reference. As Phillips does, we can first state the operational rules which in our opinion ought to be and which may be different from what we have in cooperative practice. Then we can ask what is now the best economic behaviour, the main end given (for instance, profit maximization in the cooperating units). Or we can, as Ohm does, drop every assumption regarding the value–and institutional frame of reference apart from the end of profit maximization, and then ask about the conditions of profit maximization, and afterwards try to determine what operational principles and institutional arrangements will lead to the fulfilment of the conditions. Obviously, if we choose the operational rules and other institutional arrangements *first*, we may find that the general economic conditions for profit maximization will not be fulfilled. If we choose them afterwards we may hope to find rules and arrangements by which the conditions may be fulfilled, for instance as indicated by Ohm, price-quantity fixing by the joint plant. However, it can be questioned whether or not we will end up with "cooperative associations," in the traditional meaning. As pointed out in my note:[3] "Conclusions about appropriate institutional arrangements cannot be based exclusively on analysis of the formal conditions for an optimum." For the cooperators, the institutional arrangements have a value of their own, and additional value judgements, besides the choice of the main objective is necessary. Ohm's reference to "the opinion prevailing among practical cooperators" seems to indicate that also he is aware of the role of the value judgements of cooperation. However, in my opinion the basic value judgements of cooperation, the cooperative principles, are a fundamental basis for an analysis of the cooperative associations. As stressed in my note:[4] "The principle of selection of the alternative sets of hypothetical value premises should be their relevance, determined by the principles and ideals adopted by cooperative associations in practice."

In my first note I assumed that the member firms behave like quantity adjusters. Ohm considers only the case of member firms behaving as quantity adjusters, as I do. His treatment of this case is very good and he reaches the same conclusions as I. Apart from the misunderstandings, I can see no differences in our opinions regarding this point.

According to Ohm the efforts of management towards securing profit-maximizing output, must as a rule be wrecked because of the members

[3] *Ibid.*, p. 142.
[4] *Ibid.*, p. 142.

behaviour as quantity adjusters, or because of institutional traits in cooperation. Here some more general treatment can be given.[5] Given the traditional institutional traits in cooperation, the conclusion will also be valid for members not behaving as quantity adjusters, for instance if we have one big member firm and many small. In that situation it is reasonable to assume that only the small member firms behave as quantity adjusters. And it will also be valid under different assumptions regarding the behaviour of a number of relatively big member firms, polypolistic, oligopolistic or general conjectural behaviour. The difficulties are tied up with the fact that we have many firms running a joint plant but planning individually. If the firms behave as quantity adjusters their marginal return is like the average return of the joint plant, and if they have polypolistic, oligopolistic or general conjectural behaviour the marginal return for the individual firm is also generally different from the marginal return of the joint plant.

[5] O. Aresvik, "Oversikt over visse teoretiske problemer ved våre samvirkeorganisasjoners virksomhet," *Norges Landbrukshøgskole*, 1956.

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REVIEWS

Metropolitan Growth and the Conversion of Land to Nonagricultural Uses, Donald J. Bogue. Published jointly by Scripps Foundation for Research in Population Problems, Miami University, and Population Research and Training Center, University of Chicago. 1956. Pp. 33. $0.60.

The growth of urban areas, and the consquent swallowing up of farm land, is a modern phenomenon in the United States, obvious to all agricultural economists and to most other people. As one observes one large subdivision after another around any city, and sees how rapidly in each case land is converted to city lots with houses on them, he cannot but wonder: how much land has the city taken from agriculture in the past, and how much may it take in the future? These are precisely the questions to which Bogue addressed himself. They are important questions.

Bogue set out to measure the transfer of land to urban use, and to relate this transfer to population change, and thus to derive some estimate of a coefficient or ratio linking land use to population. He tries to do this by indirection—by measuring the land lost to agriculture, rather than by measuring the land taken into cities. He uses census data for the census years from 1929 through 1954. He includes all the Standard Metropolitan Areas of the country, as these are established by the Bureau of the Census. He calculates the changes in population and in total farm and in crop acreage, from one census period to another. He comes out with 3 estimates of additional urban land area associated with additions to population, as follows:

high estimate	—264 acres per 1000 population
medium estimate	—238 acres per 1000 population
low estimate	—172 acres per 1000 population

A major strength of the above approach is that it is concerned with land lost to agriculture, and not with land actually used by cities. The two are generally not the same—as much as twice as large an area is taken from other uses as is actually used by cities. The rest is largely sterilized by the city although available for urban use in a later period. However, Bogue uses this approach because he considered that data directly showing land used by cities was unavailable.

There are several serious weaknesses to this approach as Bogue used it, and to these data. First of all, the Standard Metropolitan Areas are almost as agricultural as the rest of the United States. As this report shows, 50% of the SMA's were agricultural (in farms) land, compared with 62% in the rest of the nation. The SMA's contain many farms and much pasture

and forest land. Whereas 85% of them average less than 1,000 persons per square mile of total area, only 2% of all cities of 25,000 or more had such a low density. The SMA's are simply not urban, in a land use sense; an inspection of the frequency distributions of numbers of cities and of SMA's of specified density ranges makes it clear that they are two entirely different statistical universes. In its concern to get all the people and all the business related to a metropolitan center, the Bureau of the Census (following country boundaries, for the most part) drew its SMA boundaries so wide as to include vast areas of non-urban land.

Secondly, of the 50% of the land within SMA's that is not in farms, only about one-eighth is actually used for urban purposes. I make this estimate on the basis of calculations as to the average density of all *urban* areas in the United States in 1950. Bogue does not make such a calculation. At least seven-eighths of the nonagricultural one-half of the total area is in neither farms nor cities, but includes forests, deserts, mountainous areas, swamps, and just idle land. Very large urban expansions might, therefore, take place without any effect on farm land; or, in some cases, the area of farm land could increase irrespective of changes in urban area.

As a matter of fact, Bogue found that in 60 of the 147 SMA's, the area of farm land increased as population rose. The increase in these 60 SMA's was relatively so large that the total of all SMA's showed more land in farms in 1950 than in 1930, in spite of a population increase of 20 million. He gives 3 reasons for the increase in farm area: (1) land reclamation, (2) transfer of grazing lands from federal to private ownership, and (3) the Bureau of the Census practice of allocating ranch and farm land to the SMA where the headquarters' office of the ranch or farm company is located.

In order to get sensible-appearing results, Bogue based his calculations on four of the 13 census regions, choosing those in which both an increase of population and a decrease in farm area occurred between 1930 and 1950. These four regions form the basis of his medium estimate. Since the loss in crop and pasture land in these regions was greater than the loss in total farm area, the change in these types of land was the basis for his high estimate. On the other hand, the loss in area in his "Atlantic economic province" was less in relation to population growth, and this is the basis of his low estimate.

Bogue's calculations apply to total population and total area change within SMA's; that is, they include increases in density within urban areas, through construction on vacant lots, building of duplexes and apartments where single family dwellings stood, etc., as well as the spread of the suburban area onto new farm or other land. All cities of 25,000 or

over in 1950 had an average density of 6,610 persons per square mile: I calculate that all *urban* areas (including the smallest towns) averaged 3,310 persons per square mile. In contrast, Bogue's estimates are for 2,424 to 3,721 persons per square mile for cities of 25,000 and over–a density that seems too low, or a land requirement that seems too high, to be reasonable.

Land economists must be appreciative of this effort to throw light on an important matter, even though the results are more suggestive than definitive.

MARION CLAWSON

Resources for the Future, Inc.

Our Nation's Water Resources–Policies and Politics, Ben Moreell, Chicago: The Law School, The University of Chicago Press, 1956. Pp. 266, $3.50.

This volume is a series of five lectures by Admiral Ben Moreell, at the University of Chicago, who is retired from the Civil Engineer Corps, United States Navy where he organized the famed Seabees during World War II. He was Chairman of the Task Force on Water Resources and power of the Second Hoover Commission and is now Chairman of the Board of Directors, Jones and Laughlin Steel Corporation. The book includes a foreword by Former President Herbert Hoover.

Lecture I entitled "Federal Water Policies–Past and Present" traces the evolution of federal policies affecting water resources development. The picture presented is comprehensive and is designed to set the stage for the lectures to follow. The author writes "This in brief, is the story of Federal water resources and power policy–where we are and how we got there. I have also given a few hints as to where present policies and practices are pushing us." The broadest hint has to do with the author's objections to using the concept of "national defense" in justifying projects. He argues that the term should be given a primarily military connotation and that "the most promising method of stopping the abuse of the term 'National Defense' would be to require that all defense activities be paid for by the defense establishment directly from its own appropriations." As examples, the Air Force would be expected to choose between flood control projects and jet bombers, the Army between navigation channels and guns or tanks, and the Navy between hydroelectric power installations and aircraft carriers.

Lecture II entitled "Federal Organization For Water Resource Development" discusses the many agencies concerned with this problem and the proposals for reorganization of agency responsibilities. The author acknowledges the problem of coordination but is strongly opposed to valley authorities. He gives considerable space to debunking the accomplish-

ments claimed for the Tennessee Valley Authority. He is disturbed that foreign engineers and administrators want to see TVA. The author writes "Forgotten is the fact that Hoover, Shasta, Grand Coulee, Fort Peck . . . are among the highest and largest in the world and they were built by the Bureau of Reclamation or the Corps of Engineers, not by a valley authority."

Lecture III is entitled "Federal Development in Navigation, Reclamation and Flood Control." The author outlines in detail the devious and indefensible ways in which benefits are computed on many projects; the extent of direct and indirect subsidies; and the lack of uniformity in the assessment of costs. He points out that the final cost of a project is always higher than first estimated. He states that benefits are largely local and regional and seldom national in scope.

Lecture IV is a discussion of "Federal Power Developments." The author launched some major broadsides at other phases of federal participation in water resources development but it is on the public power issue that the Admiral opens up with his sixteen-inch guns. Public power is not cheap in cost but can be made cheap in price through subsidy. Control of power sources is basic to Fabian Socialism and "many advocates of public power are more attracted by the government ownership aspect than by the desire to serve the economy with electricity." Private enterprise can and will supply the nation's power requirements and there can be no compromise with public power.

Lecture V is entitled "The Hoover Commission Task Force on Water Resources and Power—Findings and Recommendations." It also includes a detailed statement of the author's views regarding what he considers to be the advanced trend toward socialism in the United States and the threat to human liberies. The recommendations of the Task Force appear to be broader and more moderate than the personal views of the author who was the Task Force Chairman.

This book is a valuable addition to the literature in the field of water resources development and use because it sets forth clearly the viewpoint at one extreme among those persons concerned with the problem at hand. There is no doubt where Admiral Moreell stands but his position is probably as untenable as is that of persons at the other extreme. There are several specific points which require comment by this reviewer.

Justification of projects on the national defense argument *is* overdone but the concept of national defense presented here is too limited. Also, the proposal to leave the determination of non-military defense needs to the military underestimates the dependence of the military establishment on the basic resources of the nation and overestimates the objectivity of the defense establishment in choosing between military and non-military expenditures.

There is little evidence of an understanding of the basic interrelationships of land and water resources. Foreign visitors are interested in TVA as an attempt at comprehensive and total development of resources but the author assumes the typical engineering viewpoint that accomplishment is pictured by the "highest and largest" dam. The author is skeptical of watershed management and at no point could this reviewer find a mention of multiple resource use or of multiple purpose projects.

Past experience does not support the contention that private enterprise will supply the nation's hydroelectric power needs and that public power is "all wrong." Many of the development situations where private utilities are now expanding rapidly are the same ones where the private companies said there was no demand for power and that the building of facilities was uneconomic. This includes rural electrification. There are situations where government should lead the way and develop resources when private enterprise cannot or will not do so.

With respect to some issues, only evidence was used which supported the views of the author. An example relates to the discussion of land reclamation. Land reclamation is only one aspect of the broader problem of future land requirements of the nation. There is no mention of population growth and dietary trends on the one hand or of the impact of agricultural technology on the other. In discussing the fallacy of adding to the present cropland acreage there is no mention of the loss of approximately one million acres per year of the nation's cropland to urban and industrial expansion, airport development, and highway construction. These factors were all considered in a consultant report prepared by this reviewer for the Task Force.

ROY E. HUFFMAN

Montana State College

The Grain Trade: How It Works, James S. Schonberg. New York: Exposition Press, 1956, Pp. xiv, 351. $6.00.

In this book, Schonberg has summarized and organized his vast and intimate knowledge of the grain trade. Writing as only a person can who is a part of what he describes, he leads the reader through the complex maze of the grain trade in the one way that permits the trade to be viewed as a continuous whole, which is to maintain an orientation toward the futures market. Inspection, Transportation, Statistics and News, Exporting, and Storage, each of which provide chapter titles, are enhanced in content by their envelopment among chapters dealing with futures trading. The first three chapters deal principally with futures trading, giving the reader the reference point; the next eight chapters deal chiefly with the various branches of the physical trade, employing

infrequent but valuable references back to the futures market (especially in Chapter IX on Purchasing and Processing); and the last three chapters return to the reference point to incorporate the intervening description into a fuller understanding of futures markets than is obtainable without the broader view of the trade.

The most distinguished chapters are the early and late ones dealing directly with futures trading. Chapter XIII, on Spreading, is the best of this group. It provides an exemplary discussion of an intricate and neglected facet of futures trading which will stand as an important contribution to the too sparse literature in the area. Chapter III, on Cash Grain and Futures, suffers somewhat from a common shortcoming of introductory treatises on futures markets, in that the discussion is occasionally elliptical or ambiguous. I should think that this chapter might better have taken account of the important differences among kinds of hedging. As it stands, the uninitiated may experience difficulty in reconciling such a pair of statements as the following: "In hedging there is always a simultaneous sale at the time of a purchase or a purchase at the time of a sale." "Hedging activities of such processors are more likely to be purchase of futures in anticipation of a price advance before acquiring raw products. . ." Or some frustration may result from teasing the reader with a statement like "Sound business judgment is necessary in trading in futures as hedges to offset grain contracts or against stocks of grain held in storage. Inasmuch as hedges normally do not completely match grain purchases and sales, there is a choice of futures delivery month and market left to the discretion of the operating firm." In Chapter XII, on Mechanics and Behavior of the Market, Schonberg does well in introducing the reader to the "open interest" figures and indicating the direction of their usefulness. I feel misgivings, however, that he may prove too much regarding the proportion of hedging represented in the open interest. I think his estimate of this proportion errs on the high side, and this may serve the unintended purpose of detracting from the importance that needs to be attached to speculation in considerations of the optimal functioning of futures markets.

But the special importance accruing to certain chapters by virtue of their treatment of hitherto neglected materials, or their provision of a fresh outlook upon familiar subjects, does not provide the book's strongest recommendation. This springs rather from the presentation of an authoritative overview of the grain trade in less than 350 pages. If Schonberg had not done this, I should have said it was impossible. He does it by careful selection of illustrative materials, by refraining from speculative discourse or controversy, and especially by organizing his material ingeniously. Schonberg's writing style is neither colored nor

colorful. He manages to be painstaking without being tiresome, and to be informative without being pedantic.

The book as a whole merits serious consideration as a textbook for use in courses in grain marketing. The early and late chapters on futures trading provide supplementary materials for courses in agricultural price analysis which already suffer from inadequate treatment of this topic. This book would well serve a iconoclastic teacher ready to reverse the customary procedure of assigning readings in a textbook of "principles" and providing illustrative material in classroom lectures.

The difficult gap between the academic and business worlds has been nicely bridged at an important point by Schonberg, a businessman, teacher, and scholar. We should use the bridge.

ROGER W. GRAY

Stanford University

Business Practices, Trade Position and Competition, Oswald Knauth, New York: Columbia University Press, 1956, Pp. 181. $3.00.

This belief and readable volume is devoted mainly to the business practices of firms that are characteristically widely owned, professionally managed, large-scale corporations organized for mass production and distribution. These corporations, according to the author, produce and distribute about two-thirds of the volume of product in the United States. Professor Knauth, who is an experienced businessman as well as Professor of Marketing at Columbia University, emphasizes the spontaneous and decentralized origin of modern business practices. He argues that business practices and economic structure in which they operate have developed as a matter of necessity in response to the pressures of environment.

The opening portion of the book presents the thesis that business practices in the corporate world are inconsistent with certain assumptions in the classical economics of the last century. With this thesis few economists will disagree. Modifications in 19th century theory introduced by Chamberlain, Clark, Triffin, Robinson, and others are discussed briefly later in the book but are not evaluated adequately. This weakens the basic argument.

The first nine chapters develop the concept of "trade position." A strong trade position is the goal of business organizations. This conclusion leads the author to reject the traditional emphasis on profit maximization as a motive for business firms in favor of a complex of motives, including profit, all designed to maintain trade position. He states that stability is a requisite for organization of firms and indus-

tries for mass production and distribution. He also points out that the complex nature of accounting and long-run interests of firms limit the feasibility of profit maximization on individual products as a goal.

Chapter 10 is devoted to competition and innovation. The latter is credited with an important role in preventing stagnation of the economy and in limiting durability of established trade positions of firms. In Chapters 11 through 13, Professor Knauth discusses the role of marketing, investment and government in the economy and their relationship to business practices. He is critical of some government regulatory policies, and charges that assumptions of classical economics are applied too literally in regulation of business.

The final chapter is devoted to the presentation of an alternative theory for explaining modern business practices and economic structure. The main conclusions of the work are summarized under seven headings. The conclusions will disappoint economists looking for a new theory that is simple, consistent and universally applicable. The book will also disappoint those looking for recommendations for marked changes in present practices and market structure. The author's conclusions could be interpreted as a defense of the status quo; although the author is indeed critical of some aspects of the present system, e.g. the potential for instability. On the other hand the book may prove to be a very useful antidote for those economists addicted to applying models naively to any and all problems.

The book will be of more than passing interest to students of agricultural marketing who are having difficulty in establishing appropriate theoretical frameworks for their studies.

However, in the opinion of this reviewer, this is a book to be read for a broad and sweeping view of a wide range of subject matter. It is a book with a definite point of view and as such it is not balanced on some controversial issues.

Many agricultural economists will find something to disagree with in the brief treatment devoted to agriculture in Chapter 8, pointed solely to the agricultural price problem. Also, this treatment reveals a misunderstanding of broader research, service and educational objectives of state as well as of federal agencies in agriculture and the respective roles of state and federal governments. This might have been avoided had the group of scholars consulted in each special field been larger than those indicated in the acknowledgements.

In the end, on page 174, the author returns to classical yardsticks of resource allocation, consumer satisfaction and equilibrim for judging how well the economy functions. This seems to imply, that although a

portrait of the compexities and inconsistencies of business practices and the economic structure of the real world is essential, classical logic has its place in economic analysis.

ROBERT E. OLSON

Agricultural Marketing Service

Trends and Cycles in Economic Activity. William Fellner. New York: Henry Holt and Co., 1956, pp. xiv + 411.

The four-factor statistical analysis of time series assumes that trend, seasonal, cyclical, and random components can be separately identified and isolated. Perhaps some reservations may be introduced about the final separability of cyclical and random factors, but the arithmetic processes involved are based on the implicit assumption of independent multiplicative or additive factors. Much of economic theory has similarly evolved on the assumption that cycles and trends are two separate objects of study—random factors being neglected in pure theory and seasonal influences being regarded as essentially unimportant. The theory of business cycles has grown up to be a respectable branch of economic theory, self-contained and interesting in its own right. In the last decade, we have seen a rapid development of the theory of economic growth as another separate branch of economic analysis dealing with pure trend. Fortunately, Professor Fellner's mind is not sufficiently compartmentalized to deal with cycle economics and growth economics as different subjects. He is primarily interested in the economics of growth, but he studies this problem with the preconception that trends cannot be fully understood without simultaneously understanding the cyclical mechanism. He therefore gives us an integrated book on *dynamic economics* instead of disjointed volumes on trends and on cycles.

The book is nicely balanced between statistics and historical reality on the one hand and theory on the other. The statistical treatment deals not only with frequent reference to empirical data, it also goes into the methodological problems of measurement. In an early chapter, Fellner discusses the methods of time series analysis developed by Persons, the National Bureau of Economic Research, Frickey, Schumpeter, and others. A study of historic turning points is also included.

The theoretical apparatus used is basically a Keynesian-type savings-investment model as popularized by Harrod and Domar. In one form or another, this type of theory combines a multiplier and accelerator mechanism, but Fellner often goes beyond this framework in dealing with monetary matters.

A central concept of the book is that of *dynamic equilibrium.* This is defined as a state in which there are (1) stability of the price level and (2)

balance between savings and desired investment, with government deficit nil. Fellner rules out the level of employment as a criterion for *dynamic equilibrium*. I feel quite uneasy about his concept so defined. It is, of course, simply a matter of definition but one could envisage a situation with savings and desired investment in balance at a low level of activity and prices held stable by frictions and rigidities. Moreover, would not a savings-investment balance contain the real elements of price-level stability? A dual criterion of savings-investment balance at full employment would rule out price deflation. As for price inflation, I would prefer to regard that as the consequence of savings-investment imbalance (the "inflationary gap"). In the present age of inflation, we find too little savings in relation to desired investment and also economic policy directed towards stimulating savings to a level high enough to maintain price stability.

To a large extent, Fellner's analysis is most pertinent to the problems of Western industrialized economics. Surely the study of growth in the most exciting areas of application today cannot ignore the central problem of huge masses of unemployed or inefficiently employed labor. Fellner's concept of *dynamic equilibrium* does not seem to give adequate expression to many criteria that come to mind in characterizing a correct state of economic growth for the nonindustrialized countries of the world, such as population control, labor force development, full employment, balance between primary-producing and industrial sectors, etc.

Given Fellner's definition of *dynamic equilibrium*, one can appreciate his three corollaries. (1) There must be an improvement process raising the marginal productivity of capital in order to maintain investment. The qualification is introduced that the labor-saving character of the improvements must not be so great as to cause chronic unemployment. (2) Structural change must be gradual and accompanied by sufficient mobility of resources to avoid bottlenecks and other crucial obstacles to a smooth flow of economic activity. (3) Legal and institutional factors must be compatible with regulation of the money supply in accord with the equilibrium needs of the economy. This last corollary is connected with the price level criterion.

There is in the book a general discussion of cyclical disturbances to trend growth. This is largely a general review of the field of business cycle analysis, but it is properly related to the earlier discussion of growth and trends. I find myself most interested in the section of the book dealing with the author's appraisal of the usefulness of mathematical and statistical models of the economy. In general, Fellner is quite skeptical of the use of such methods and, though his underlying model is similar, he refrains from making it a logically complete system. He prefers

a looser framework based on less well-defined and less clear concepts than are found in the mathematical systems. I do not appreciate his point of view in this respect, but cannot do more within this review then note the issue.

In a final section Fellney takes up problems of policy and recent economic history. Here his views on Soviet growth, fiscal policy, monetary policy, trade unionism, economic security, and the stagnation thesis provide stimulating material. He draws a very fair picture of our times and leaves the reader with strong foundations for confidence in the economic growth of Western nations.

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Technical Assistance by Religious Agencies in Latin America, James C. Maddox. Chicago: The University of Chicago Press, 1956. Pp. xi, 139. $3.50.

The expression "technical assistance" has become a fad, meaning all channels through which useful knowledge and skills are shared and banded together to improve the standards of living and hence the general prosperity of the various peoples of the world. We are inclined to forget that technical assistance is not new. It has been given and sought from times immemorial. The Egyptians, the Greeks, and the Romans, indeed any imperial nation, had probably given just as much "technical assistance" to less well-developed areas. What is new about it is the formal organization and the rapid expansion of the public and private programs which have recently evolved to furnish technical assistance, as a result of the widespread belief that it constitutes a more efficient agent for furthering international cooperation and understanding. Perhaps some would argue that it is put into effect for solely humanitarian reasons. Although the private programs represent merely a continuation of the long-established channels through which knowledge was shared and spread, the public ones, at the international level, constitute an innovation and are symbolized in the bilateral technical cooperation programs of several technologically advanced countries, and in the multilateral cooperation programs of several international organizations.

The book under review deals with one of the long-established channels for the transfer of knowledge—that undertaken by religious agencies. It treats exclusively of those which, having headquarters in the United States or being staffed with United States personnel, operate in Latin America. (The book is an outgrowth of work done by the author as a member of the research staff of the Special Policy Committee on Tech-

nical Cooperation of the National Planning Association which undertook the task of determining the extent to which the "sharing of useful knowledge was helping the underdeveloped countries [of Latin America] to help themselves or to see what its benefits—tangible or intangible—were to the United States.")

Although technical assistance might have been conceived as an instrument to foster cooperation and understanding, or as a humanitarian endeavor, the programs of technical assistance rendered by religious groups appear mostly to be instruments of expediency. The primary objective of missionary movements has been proselytizing. However, it has been realized for some time by some religious leaders that this aim could not be achieved exclusively through preaching and the dissemination of religious literature. Although they maintain "that salvation is in Christ, [and] not in modern techniques and technology," a large number of "leading theologians agree that a wide area of social service activity is a necessary part of church responsibility." Hence, several religious denominations through their respective missions have resorted to the rendering of several technical service activities in the fields of education, health, agriculture, social service, and industry, thus imparting a great deal more than religious ideas.

The analysis of the scope and nature of these technical service activities in Latin America constitutes Dr. Maddox's effort in this volume. The book starts with a short, though adequate, summary description of the major characteristics of Latin American society to serve as background material. The study reveals that out of 175 religious groups operating in that area, 66 different groups from the United States—Protestant, Catholic, Jewish, interdenominational—have technical assistance projects in every country of Latin America. This work, to which more than 2,100 North American missionaries devote full time and for the support of which somewhere between 8 and 10 million dollars from United States sources alone are annually contributed, accounts for something like 40 percent of the United States missionary effort in that region. This is obviously a large contribution. To further demonstrate that the technical assistance work undertaken by these religious agencies constitutes "a major avenue for the flow of technical knowledge to Latin America," the author points out that only 664 United States technicians were employed for work in Latin America by the government in its bilateral technical cooperation programs with the countries of that area in 1954-55, and that the Federal contribution for these activities during that period was about $22,000,000. Thus, the religious groups devote three times as many persons to their technical activities as does the government, but spend only about half the amount contributed by the government for technical cooperation programs in Latin America. The author could have well strengthened his case

here by stating also in this connection that for the projects undertaken by the United Nations in the countries and territories of Latin America under its Expanded Technical Assistance Program, only 557 experts were provided and that its total costs only amounted to about $5,500,000 during 1955.

Although the work done by religious groups is different in many respects from the type of technical assistance given by other agencies, mainly on account of the fact that this work is linked to churchwork and evangelism, the religious agencies have centered attention and pioneered in areas of activity "that later became the focal points for the publicly financed technical assistance programs. . . ." Education, through the sponsoring of more than 1,000 primary schools, 145 secondary schools, and nearly 60 technical schools, receives primary emphasis. Health work, with 119 hospitals, clinics, and nursing schools, ranks second; and agriculture, with its 43 projects, takes third place.

The nature of the religious agencies' technical work is described and analyzed both in general terms and through selected examples. In both opportunities the author quite adequately describes the environment in which the activities take place, the prevailing systems, and the ways in which the projects are carried out. This is done to emphasize the hardships of the work and to evaluate its outcome.

The author establishes that the religious agencies have efficiently used their resources in their technical service work in Latin America. He raises many interesting criticisms concerning quality and performance without minimizing the general success of these religious technical services-criticisms that the reviewer shares. The religious agencies are not continuing to succeed as previously, considering the effort expended, in improving educational methods, nor in bringing education to the neediest, nor in emphasizing preventive rather than curative medicine, nor in promoting agricultural extension and community services rather than research and production, fields in which they cannot properly compete with better-financed, publicly-sponsored projects. As the author concludes, the religious groups ought to keep up with new developments in Latin America in general and to coordinate their programs among themselves and, if possible, with those of other public and private agencies. This reviewer hopes that this book, which has merit also because it deals with a subject that has been rather little explored, will serve as a guide to the religious groups engaged in planning or undertaking technical assistance work in Latin America.

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Plant Location in Theory and in Practice: The Economics of Space, Melvin L. Greenhut. Chapel Hill: The University of North Carolina Press, 1956, Pp. xiii, 338. $7.50.

This book represents an effort to develop "a framework that includes all the possible factors (general and special) which determine plant location in a capitalistic state"; to free location theory of the weaknesses consequent upon early efforts to generalize it to all types of economies; to express the site decision as an integral part of modern enterprise theory and thus to extend the framework beyond the special assumptions of atomistic competition; to demonstrate the inadequacies of both the old least-cost location theories and the newer market-area theories of locational interdependence; to reconcile and to integrate these two formulations into a maximum-profit structure specifying the relationship of location decisions to all enterprise profit determinants rather than merely to least cost in certain phases of production and transfer or to maximum market areas; to provide specifically for manipulation through the locational process of both cost and revenue functions as well as for adjustment thereto; and to appraise the naked maximum-profit target, free of reference to nonpecuniary goals or to uncertainty, as the basic governor of locational patterns. The book is largely aimed at professionals, with some parts held to be suitable for advanced students.

The structure of the book may reflect these broad aims. From a competent general review of least-cost and market-interdependence formulations, a tentative statement of a location theory of the profit-maximum type is developed. Then, there is detailed consideration of each of several of its major locational profit determinants—transportation and processing costs, product demand, the cost-reducing or revenue-increasing factors functionally dependent upon location, and the "personal factor" as a possible means to constrain the maximum-money-profit target of enterprise theory and to adjust it for uncertainties. Next, there are eight case studies of locational decisions by Alabama firms in which the completeness of the theory and the validity of some of its implications are tested on a loosely quantitative basis. The author seems aware that the bases for selection of these cases and the analytical methods applied to them preclude precise expression of the reliability or generality of his conclusions. He finds at least general support for the implications of his theoretical structure that all cost and demand functions dependent upon location are usually considered in the location decision, that one or a very few of the specific determinants dominates in each decision, and that the "personal factor" appears sufficiently important in these few cases to justify reconsideration of the purely monetary maximization category of enterprise theory. So there is a final section, again consider-

ing the least-cost, the interdependence, and maximum-profit statements of location theory and again leading to restatement of a maximum-profit version of location theory modified by variability of both cost and demand functions and by adjustment of the purely monetary maximization category for temporal uncertainty and nonpecuniary motivations. In the final statement of the theory, three sets of locational determinants—demand, cost, and personal—are listed. To achieve "the long-run focus, the distortive types of man-made forces such as freight rate zones, discriminatory pricing, tax incentives, and state and federal laws" are stripped out of the list. Although alternative formulations are conceded, the author finally decides to frame his system around a pecuniary profit target allowing, as necessary or desirable, adjustment for personal factors either as cost- or demand-function adjustments. This is done to avoid a "possible loss in econometric type of research possibilities" and since a maximum-satisfactions category alone "would not make economics dynamic." There follow very brief verbal and symbolic statements of a "general theory," which the author says is "only such and nothing more; it does not offer predictability of future locations" and presumably will not generate testable hypotheses.

Yet, this does seem generally to be an internally consistent system meeting the major purpose for which such systems should be built. It does indicate the major determinants of locational optima and their likely interrelationships under the constraints of various institutional or competitive structures. As a source for usable research hypotheses, it should be as fruitful as most other available theoretical formulations and rather better than most. The first part of the book was difficult to work through, especially the sections attempting to generalize a coherent structure out of particular arithmetic models. The methodological limitations of the case studies are severe. The second section on specific determinants should be useful reference material. This is in no sense either a theory or an analysis of industrial localization. Rejection in the final theoretical structure of some of the implications of his empirical inquiry does not seem clearly justified. I am not sure that I know how the author would answer two quite relevant questions: (1) what is a theory and (2) what is its purpose? Primarily as an explicit exposition of the possibility of fitting the site-location decision of the firm into received theory of the firm, this book is a desirable addition to locational literature.

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Impact of Price Expectations and Uncertainties on Decision Making By Poultry Firms, T. C. Morrison, G. G. Judge and E. H. Tompkins, Bulletin 320, Storrs Agricultural Experiment Station, Connecticut, p. 63.

This bulletin reports the results of a study of the changes in production plans and price expectations of 62 egg producers and 36 broiler producers. Changes in production plans were ascertained over a recent past 5-year period. Price expectations were ascertained for specified periods in the immediate future.

The methodological approach and the results of the price expectation and reaction to uncertainty analysis were much the same as those used and secured in the several other studies covering this general area. Mean expected prices and a range around them were secured. Recent past prices were given as the most important reason for the level of the future estimates. Producers, also in agreement with other studies, seemed to prefer uncertainty to certainty. They insisted upon receiving a higher certain price than their previously stated estimates of future prices. When producers were asked concerning their production responses to a series of prices known in advance, supply elasticities were above one. However, when questioned about their probable response to depressed prices, producers said they either would make no change or would go out of business.

Generally, it would seem that unless new research approaches can be devised, work in this area is not likely to produce very fruitful results. Why do these studies conclude that farmers prefer uncertainty and yet in practice they act to protect themselves against it? Theoretically uncertainty does have a cost. And in the real world of the broiler industry it appears that growers recognize this and are willing to pay to transfer uncertainty to someone else. Major feed companies who are heavily involved in the various fixed or guaranteed income schemes in broiler production insist that growers know such schemes have a cost. However, growers apparently are choosing to pay the price for income certainty.

Perhaps the weakest assumption made is that the principal uncertainty is that of prices to be received for the product and that producers in planning form an opinion of probable future price ranges and probabilities. In this study only slightly more than 50 percent of the producers would venture such future price estimates. Such a situation immediately should raise the question as to whether or not producers really do formulate such opinions. Many of the other findings reported in the bulletin point to the conclusion that much of the short-run production planning is done in terms of technological and physical limitations and not in terms of price and cost expectations.

The greatest potential contribution of this study is probably in its "sec-

ondary" findings of the nature of production adjustments. Particularly interesting is the analysis of production adjustments made by operators of different sizes of plants. The hypothesis that small producers tend to expand and contract their operations proportionately more than larger specialized producers is tentatively rejected. No difference was found. Instead, it was found that absolute changes in production were more the result of shifts in the larger operations because of their greater importance in the total production picture. Adjustments in physical facilities, rate of culling and other interesting production findings are also given.

Those interested in the poultry industry will find much to think about in this bulletin. Those interested in the empirical analysis of uncertainty will not find in this bulletin any new insights into the problem. They should read it, however, with the hope that in travelling down the same old road again they may obtain an inspiration for a new, and perhaps better, path to follow.

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Possibilities for Increasing Production and Incomes on Small Commercial Farms, Southern Piedmont Area, North Carolina, J. G. Sutherland and C. E. Bishop, Tech. Bull. 117, North Carolina Agri. Expt. Station and Production Economics Research Branch, Dec. 1955.

Brief study of this bulletin a few months ago led this reader to classify it as a workmanlike job, illustrating the possibilities and limitations of linear programming in farm organization research. Subsequent obligations as a reviewer led him to the appendix tables and a startling discovery. Now, he is eagerly planning for a late winter vacation on a very small commercial farm in the Southern Piedmont of North Carolina, where labor, under the optimum combination of enterprises, will have a marginal product valued at about $8.50 per hour. Other North Central economists interested in this phenomenon are invited to accompany him.

Marginal productivities varying from nothing to $8.50 per hour of labor at various periods during the year result, in part, from the authors' commitment to single-point estimates of input-output relationships for each of the several farm enterprises. In fact, of course, such wide variations in marginal productivity would call for adjustment in use of labor within enterprises as well as among them. Also, monthly supplies of family labor may be more elastic than the authors suppose.

That family workers on these farms will refuse to stretch their working hours during critical periods is but one of the many assumptions followed rigorously in the programming computations. The authors have little to say about this particular assumption, although one of them has

noted elsewhere that farmers of the area are quick to forget certain "preferences" which conflict with net revenue.[1]

The same author has noted the especial appropriateness of programming procedures for intrafirm analysis, in contrast to the clumsy tools of budgeting.[2] Yet Technical Bulletin 117 states that individual farm planning is the preferred method of ascertaining the most profitable adjustments in farming. Does programming really offer a more effective technique than budgeting for large-scale individual farm planning under varied conditions?

If small commercial farmers were to accept the results of the initial programming analysis, laying flocks in the Southern Piedmont would be expanded tremendously; hence the authors have been careful to compute new optima under alternative price assumptions. Realistic *individual* planning on a larger number of farms, however, would doubtless have revealed a wider variety of optimum solutions, whether the method had been programming or budgeting. Failure to throw much light on the variability of adjustment opportunities characterizes the widely used technique of limiting intensive study to three or four "typical" units chosen to represent as many classes of farms.

This bulletin, along with other early applications of programming, deserves study by economists concerned with questions of economy in their own research activities. To what extent can we rely on refined analyses for a few generalized but "typical" situations, as compared with cruder yet more realistic study of larger numbers of actual farm situations? This question, of course, faced budgeters before programming techniques received widespread attention. It acquires added importance when joint relationships among optimum enterprise combinations and optimum production techniques within individual enterprises are recognized.

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[1] C. E. Bishop, "Programming Farm-Nonfarm Allocation of Farm Family Resources," *Journal of Farm Economics*, Vol. XXXVIII, No. 2, May 1956, p. 401.
[2] *Ibid.*, p. 397.

The Economics of Consumption, Willard W. Cochrane and Carolyn Shaw Bell, New York: McGraw-Hill Book Company, 1956, Pp. viii, 481. $6.50.

When the born economist undertakes to expound the "economics" of any segment or facet of the economy, inevitably he finds himself embarked upon a tour of the entire realm. So it is with Cochrane and Bell in their *Economics of Consumption*. Attempting a text that "describes

and analyzes the decision making of households within the frame of reference provided by modern economics," they explore, before they are through, equilibrium-price analysis, monopoly and competition, social accounting, public finance, and economic stabilization including the consumption function and the multiplier, with side excursions into social psychology, sociology, and political science along the way. The chief area passed by—with obvious reluctance but with references to other guides—is the production function as the determinant of the supply curve of the firm.

The text is intended for "a course that builds on the principles of economics and develops one of its many applied fields namely the economics of consumption." One suspects that a better-than-average principles course would be a handy prerequisite.

It is definitely an economics course that the authors intend, not one for the home-management curriculum, much less one in merchandizing. They "concentrate on developing an understanding of the decision-making processes in consumption rather than the provision of information for use in decision making." The student who masters the text will have had a broad second course in economics, as well as a comprehensive review of the present state of knowledge of consumers' behavior, individual and collective.

The student will also be well on the way towards becoming an acceptable member of the economics fraternity—or will at least have had a liberal exposure to the manner of speaking and thinking in that fraternity. For the authors seem frequently to feel the need of justifying themselves before their colleagues on doctrinal matters that may hardly seem problems to students uninitiated into the fine controversies that plague their professors. Along with this goes a prolixity too often typical of professional writing, plus an attempted cuteness of illustration not too successfully imitative of some of our English colleagues. The hungry man making himself sick on candy bars presents the principle of diminishing marginal utility laboriously, rather than with the succinct charm of Wicksteed's child remarking "Second helps are never as good as first."

In this reviewer's opinion, at any rate, the text goes to unnecessary lengths to explain not only where it intends to carry the reader but why, and often to apologize for going there or for having found so little of use when it got there. The first chapter spends several pages justifying the scope of subject matter to be encompassed and the final chapter spends considerable space justifying appending a statement of the authors' views on certain matters of policy (it may furnish the reader perspective for appraising both their work and the problems discussed, and the views may themselves even have some merit). A similar, wordily defensive tone pervades many intermediate chapters.

The basic approach is traditional-theoretical, in that the "received theory" is expounded first and appraised second, rather than developed through descriptive exposition and gradually woven into a systematic whole. (The treatment, however, is non-mathematical, a complicating handicap that still seems inevitable in texts at this level.) The authors seem constrained to this approach by their own low opinion of much of the theory.

Regarding consumer choice they state, "Economists have formulated an elaborate and, we shall argue, a plausible although not very useful, theory of choice." This theory they expound in terms both of utility functions and of indifference curves. They then seek help, but find chiefly discouragement, in recent psychological approaches (Norris, Katona, Bilkey). They prefer to pin their hopes on future direct experimental measurement of utility following the lead of Mosteller and Nogee.

Similarly with demand and price formation the traditional theory is expounded for what it is worth and is found to "permit a conceptualization, hence an understanding, of the key roles played by demand and supply in the market involved." But in comparing the real world with their models they conclude on the supply side that "nonprice competition is characteristic of most consumer markets today," and on the demand side that "consumer choice in the real world is far more complex than that envisioned by the price-analysis models of previous chapters."

The critical student may reasonably question why he has been put through these arduous exercises if the muscles thus developed have so limited use. He will, however, have been offered a good many penetrating and stimulating observations on problems and practices of consumers and businesses that should substantially enlighten him even though they do not provide "understanding" in the form of neat theoretical models.

The authors deal extensively with the large role of government in the modern economy as purchaser of a substantial share of the national product, as an influence in economic stabilization, as a redistributor of income from the standpoint of welfare, as a protector of consumers in the market. The treatment is objective and analytical, not propagandistic. It should give the student tools for appraising economic consequences of a broad variety of government programs.

Preoccupation with theory perhaps explains the rather sketchy treatment of a few topics that some would expect to find more fully discussed. The classification of consumer information, for example, leaves no place to mention grade standards for consumer goods (as distinct from the regulatory minimum standards under pure food laws—itself a topic condensed to the point of cloudiness), nor voluntary certification by agencies like the Underwriters' Laboratories. Consumers' cooperatives are defined out of any distinctive existence. Voluntary associations as vehicles of

"collective consumption" are briefly classified but the authors find little data on their importance and turn main attention upon government–which publishes statistics.

The text comes complete with chapter-by-chapter "Questions and Points for Discussion" and references for supplementary reading. A revised edition could be made more useful by fuller indexing, especially of authors cited, and improved by correction of errors like reference to the "Full Employment Act of 1946" ("Full" was compromised out of the title before enactment).

We have here, in brief, a text providing a broad exposure to modern economics for the second-course student approaching the subject from an interest in consumption. The student will feel that he has been made to earn his grade in the course. If he earns an "A" he will come away with a considerable knowledge of the public as well as the private consequences of consumption decisions in the complex economic life of present-day United States, an awareness of the many-sided importance of government in it–plus a sense of the frustration of economists for whom "understanding" requires its reduction to simple mechanical analogues after the pattern of the "received theory."

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Population Growth and Levels of Consumption: With Special Reference to Countries in Asia, Horace Belshaw, New York: Institute of Pacific Relations, 1956. Pp. xxix, 223. $4.50.

Professor Horace Belshaw, Macarthy Professor of Economics at Victoria Union College, Wellington, New Zealand, has written this book with the purpose of examining the relationship between population growth and levels of consumption in so-called underdeveloped countries in Asia. The work is divided into three major sections: the first deals with aspects of the population situation in Asian countries, the second with some fundamental relations between population increases and economic development, and the third with general conclusions. There are also two short appendices: "Note on the Utilization of Idle Labour" and "The Community Project Approach."

The first section of the book gives some analysis of the rate of population increase in most of Asia (though Asia is never delineated, a point of interest only because the Introduction refers to Israel as one of the two developed countries in Asia). This section includes a wide range of considerations; among them is that declining mortality rates resulting from exogenous factors such as disease control, better medical services, DDT, etc., are occurring in the face of high fertility rates which persist be-

cause of endogenous factors such as familial relations, structure of agrarian society, etc. As a consequence of this demographic pattern, we are presented with the staggering fact that at present rates of growth, the population of Asia, excluding USSR, will have increased by 360,000,000 people—or nearly the present population of India—in twenty-five years. The rest of the book is addressed to the problem of how levels of per capita consumption can be maintained or increased in the face of such a population increase.

At the outset, it should be stated that despite Professor Belshaw's claim to be a mildly optimistic neo-Malthusian, he does not care to state whether his analysis leads him to believe that consumption levels will indeed rise in the face of this population increase, nor does he care to predict whether this population increase will materialize. One has the feeling that this is done because there is something distressing about making dismal predictions, or else because past experience has indicated that unexpected developments in technological and other fields have confounded the direst of predictions and thus have led many of us to be unscientific enough to pin our faith on a "Micawberish" hope that something will turn up.

However, even though one might hope for deliverance from the Malthusian spectre by application of new technologies and distributive devices, there can be no gainsaying the harsh realities involved in raising Asian per capita consumption levels in the present circumstances. Problems of economic development are formidable, with perhaps the most urgent being that of finding the means whereby the circle of low income, low savings, low capital formation, low production, low income can be broken, particularly in the face of a rapidly increasing population. In discussing this problem, Professor Belshaw delves into the issue of capital formation with some discussion on savings, investment, productive use of labor, difficulties of introducing new technologies, and requirements for the acceptance of innovations. As might have been anticipated, he concludes that the only way to increase levels of per capita consumption is to increase output and, if possible, to stabilize the rate of population growth. Increasing output would call for increasing capital imports, encouragement of new techniques of production, organization of labor for more efficient use, and mobilization of idle labor via community development projects; population stability would come with changed attitudes and education, both to be fostered by investment in social overhead.

Professional economists will be somewhat disappointed at the rather superficial way in which the whole process of economic development has been handled. Even though a limited number of specific examples are

used for expository purposes, the discussion is very general in nature. Probably limitations of space and time could hardly make it otherwise in a book which covers topics as diverse as population problems, cultural attitudes toward change, community projects, and desirable levels of capital intensity for economic development. There also seems to be a somewhat uneven treatment of some of these subjects; for instance, a good part of one chapter is devoted to presenting an explanation of the Cobb-Douglas equation so as to convince the reader that there is a need for capital growth or economies of scale to accompany increases in the labor force, if production is to rise. In contrast to this, there is very little said on the peculiar problems of agricultural development, even though the populations of Asia are primarily engaged in agriculture. This leaves the impression that the major emphasis for development to raise consumption levels lies in the acceleration of industrialization without due consideration of the relationship between agricultural and industrial development.

This book is recommended reading for those who would like to have an understanding of some of the problems confronting modern Asia (though many of the references would seem to indicate that the book was long enough in press to "date" it somewhat), and perhaps for those who wish to know something based on first-hand observations of problems of technical assistance, Asian attitudes to innovations, and the village-community approach to economic development. It is in these latter areas that Professor Belshaw seems to feel most at home.

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La Localisation Des Cultures et Des Productions Animales en France, Joseph Klatzmann. Paris: Institut National De La Statistiques et Des Etudes Economiques, 1955, Pp. 477.

Mr. Joseph Klatzmann, Administrator of the French National Institute of Statistics and Economic Studies, sets himself the three-fold task of describing the present location of agricultural production in France, of explaining the reasons for the present pattern of locations and then of presenting a mathematical formula for the rational location of agricultural production. To a surprising degree he accomplishes his objectives.

The book is divided into three parts; each part addressed to one of the objectives. Part I, which runs for 200 pages, describes present locations by means of 50 spot-and-crosshatched maps, 15 pages of statistics, a number of ingenious graphs and just enough text to explain and describe the maps, graphs and data. It constitutes a useful reference work on the location, organization and intensity of French agriculture.

Part II takes up the problem of explaining the location of production

enterprises by a further generous use of maps, graphs and charts, and the minimum necessary text for 120 pages. The problem of explanation is continued for 30 additional pages by a series of 18 case studies. These cases are from four different regions. They illustrate reasons for locations under conditions of different farm sizes, crops, management abilities, technological levels, soil and climate conditions, historical development and market situations. They suggest, even more convincingly than do the maps and charts, the almost infinite number of combinations of these factors obtaining in a country having the variety of conditions found in France. Incidentally, but very effectively, the case studies make a strong argument for the need for improved and expanded techniques for the distribution of technical information to agricultural producers. In sum, the case studies are well written and add a great deal to the reader's understanding of the operation of factors affecting the location of agricultural production.

The last section of Part II consists of 60 pages on the changes in the location of production that have taken place during the last century. This is done by the use of more than 200 crosshatched and shaded maps designed to show changes in actual areas and also on a percentage basis. The censuses of 1862 and 1949 provide the statistical bases for most of these maps. This section demonstrates very clearly the changes between two points in time; but it does not contribute much in depth of understanding of why and how the changes took place.

Part III is called "the theoretical bases for a theory of rational location of agricultural production." It comprises 50 pages and includes both a statement of the theoretical framework for the discussion and a mathematical study of the problem of where agricultural production should be located. This theoretical and mathematical discussion constitutes a marked change in pace from the maps, charts, graphs and narrative of the first 418 pages, but it is tied to them through its continued concentration on the subject of agricultural enterprise location. In this part Mr. Klatzmann makes a concise and clear statement concerning the nature of the assignment he has undertaken, the data necessary for such a project, the criteria to be considered, the definitions of key terms and the possibilities and limitations of the mathematical method. An example of his logical method is his discussion of the concepts of *productivity* and *progress*. He discusses several concepts of *productivity* and then concludes that it should be defined in terms of all of the factor inputs. He then defines progress as improvement in this total productivity. His definitions are significant in that they directly relate productivity to the level of living of a country. The final conclusion of Part III is that more data and more man power will be required to solve the optimum-location problem by use of equations.

A striking fact about this book is the variety of analytical methods and techniques the author uses. In addition to the use of mathematical methods and case studies (methods which were pioneered by French economists), his use of such techniques as cartography, graphics and statistics, serve as interesting examples of the effective use of these tools.

This book will be of considerable interest and use to anyone working in the fields of French agriculture, location theory, or methods and techniques of economic analysis and presentation.

For a brief resume of this book by the author, plus a lively discussion by half a dozen leading French agricultural economists, you are referred to the April 1956, *Economie Rurale,* the bulletin of the *Societé Française D'Economie Rurale.*

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Texas A. and M. College

Comparative Economic Development, Ralph H. Blodgett and Donald L. Kemmerer, New York: McGraw-Hill, 1956. Pp. 557. $6.00.

Writers of textbooks in certain fields face something of a dilemma these days. If the subject deals with political economy and the book is to sell, it must meet the vigilant standards of textbook-screening committees who, according to press reports, increasingly demand a 100-percent brand of Americanism. A casual waving of the flag will not do. It must vibrate at a Presleyan clip.

On the other hand, the conscientious author is assailed with the dread that some professional colleague will take time to read his offering. He may have selected his facts or shaped his emphasis in order to give free enterprise a bit of the edge in the rivalry of economic and political systems. If he has done this, therein lies the prospect of academic criticism.

This book is an example of skillful navigation between these twin hazards. Touted as a "pioneering textbook for freshmen and sophomore economics courses," it presents a comparative analysis of capitalism with the United States as the specimen country, the welfare state (Great Britain), totalitarian socialism (Russia), and fascism (pre-war Germany). The restoration of capitalism in Western Germany since the war is also treated in the chapters dealing with fascism or National Socialism.

With slight variations in wording, each major section is rather tightly organized around seven topics: (1) area, population, and resources, (2) agriculture, (3) transportation and communication, (4) industry, (5) finance, (6) labor and (7) commerce. Summary observations appear at the end of each section and a general concluding statement is made at the end. The various phases of development in the economies of the four sample nations are discussed in historical sequence, frequently interlarded

with comparative references.

On the whole, this publication represents a laudable enterprise. The authors tackle with considerable success the hard task of simplifying for undergraduates a skein of complex material that often baffles mature scholars. In spots, they show real courage in dealing with the many value-loaded questions inherent in such an undertaking. In the case of the Soviet Union, the authors are obliged to fall back on data of doubtful quality; for Western Germany, they lean mainly on newspapers and periodicals. But they make a good deal out of available sources and consistently send up warning notices on questionable items.

An element of suspense awaits the reader who is interested in how to function in a climate of neo-chauvinism without distorting the facts. Much as in the tradition of professional wrestling—the probable winner is pretty well identified before the match gets under way. The hero, a clean-limbed youth with an open face and a penchant for fair play, bears a remarkable likeness to Capitalism. Arrayed against him are Communism an inveterate eye-gouger; Fascism, who favors the kick in the crotch; and Welfare State, who probably owns the referee. That Capitalism will emerge the winner is never for long in serious doubt, but there are some trying moments.

Capitalism sustained a body slam into the third row during the 1930's and returned wearing a new ring costume. Despite technical weaknesses, Welfare State survived many an airplane spin and continued to please his partisans. Fascism was persistently ruthless, but until the end kept his followers exhilarated and busy. Communism, notwithstanding Capitalism's moral victory, staked out two-thirds of the arena and was holding off the cops when the television set blew a tube.

In fairness to the sponsors of the show, it should be noted that ". . . the geography, the resources, the history, and the economic problems faced by each of four nations determined to some degree the type of economy that it eventually developed." Moreover, ". . . we should try to relate the methods and results of each economy to its own goals and objectives." And while ". . . the United States is the undisputed champion of the world . . ." in production and real income, even the rugged National Socialist methods ". . . differed only in degree rather than in kind from government controls which are sometimes employed under capitalism."

Some agricultural economists may be depressed by the lumping, in this volume, of the farm program with an "inflexible and costly" drive for security. Nevertheless Messrs. Blodgett and Kemmerer have achieved a compact digest of reference data on the timeliest issues of the day. It is something more than home work for the freshman and sophomore.

JOE R. MOTHERAL

Agricultural Research Service

Kibbutz—Venture in Utopia, M. E. Spiro, Cambridge: Harvard University Press, 1956. Pp. 226, $4.50.

Many underdeveloped countries are today trying to increase agricultural production "the cooperative way." Their agrarian leaders are eager to read the available leaves of experience. This is why literature on cooperatives is having a heyday.

The Israeli Kibbutz (cooperative farm) is described in a legion of publications. Few are however the analysis of the sociological, economic, psychological and political factors. Here is where Professor Spiro (U. of Connecticut) steps in. This book is an anthropological case study in group dynamics of a venture in utopia. He tries to find out what makes Kiriat Yedidim a flourishing communal society that is uncompromisingly pro-Soviet, Marxist and strictly anti-religious.

Members of this Kibbutz repudiate individual citizenship for the sake of total allegiance to the community. They believe that agricultural labor is a primary objective of life. Yet these people are not farmers by background, but middle-class European intellectuals. Accordingly they give most respect to "the synthetic personality"—the member who can at the same time withstand toil and give the community moral and intellectual leadership.

Professor Spiro, who for 11 months lived and worked with his wife in Kiriat Yedidim (a fictitious name) takes us into the very center of this living community. He succeeds to recreate a most tangible impression of the patterns of work and play, politics and passion, life and death, unity and conflict. He is master at analysing the frustrating attempts at reconciliation of reality and ideology. The outside world is constantly creeping into the lives of individuals. The lofty communal ideals are being watered down by natural desires for a greater degree of privacy, return to more traditional family life.

It is probably not too surprising to note that the partial reverting to conventional ways applies primarily to the old timers who founded Kyriat Yedidim. Quite a few of these pioneers have left the Kibbutz; none of their children have. Apparently the collectivist up-bringing to which these children were exposed makes them immune towards the temptations of conventional ways of life.

Prof. Spiro intends to write a separate volume dealing with the second-generation members of the Kibbutz. In this way the first volume serves as an appetite wetter for another master piece in applied anthropology.

FRANK MEISSNER

Golden Gate College, San Francisco

NEWS NOTES

JAMES G. ALLGOOD has joined the staff of the Department of Agricultural Economics at North Carolina State College as Farm Management Specialist.

DONALD E. ANDERSON, former graduate student in agricultural economics at the North Dakota Agricultural College, was appointed teaching Instructor effective September 15, 1956.

RAYMOND ANDERSON, Production Economics Research Branch, ARS, cooperative agent in Montana, is on leave at the University of Wisconsin, where he is working toward his Ph.D. degree.

E. L. BAUM has been named Chief, Agricultural Economics Branch, Division of Agricultural Relations, Tennessee Valley Authority.

HAROLD D. BAUMAN joined the staff at New Mexico A & M College on September 15, 1956 as Extension Economist, Fruit and Vegetable Marketing. Bauman received his B.S. degree in 1949 and his M.S. at Oklahoma A & M College in 1950. Prior to coming to New Mexico A & M he worked with a progressive farm cooperative in New Mexico.

G. M. BEAL, Professor of Agricultural Economics, University of Maryland, returned October 1, 1956, after spending 10 months in Greece on a Fulbright Scholarship.

SIDNEY C. BELL recently joined the agricultural economics staff at the Alabama Polytechnic Institute as Instructor in Agricultural Economics. He will continue graduate study at A.P.I.

M. R. BENEDICT, Professor of Agricultural Economics at the University of California has just returned from sabbatical leave spent in Holland, West Germany, Austria, Yugoslavia, Greece, Turkey, Italy, Switzerland, Spain, Portugal, France and the United Kingdom. This extensive travel was made possible through a Ford Foundation grant for the "Study of Methods and Objectives in Liquidating Excess Stocks of United States Farm Products."

DAN W. BICKLEY was recently appointed Assistant Agricultural Economist at Clemson College. Mr. Bickley received his education at Clemson.

JOHN BLACKMORE has been placed in charge of FAO's work in the general field of land policy.

KENNETH F. BLASE has joined the staff of the Production Economics Research Branch, ARS, where he will carry on research on low-income farms. He recently received his M.S. from the University of Missouri.

JOHN BREWSTER has joined the staff of the Production Economics Research Branch, ARS, transferring from the Agricultural Marketing Service. He

will serve as a special assistant to the head of the Production, Income and Cost Section.

DAVID W. BROWN accepted an appointment at the University of Tennessee as Assistant Agricultural Economist and Assistant Professor in Agricultural Economics on September 16. Mr. Brown has done graduate work at Cornell University and completed his Ph.D. requirements at Iowa State College.

LUMEN E. CAIRNS, who received his Ph.D. degree from Iowa State College early in 1956, was appointed Assistant Agricultural Economist at Washington State College September 1, 1956.

THOMAS F. CARROLL has accepted a one-year assignment as an FAO expert to advise the Government of Chile on Land Reform problems.

E. D. CHASTAIN, JR., who recently received a Ph.D. degree in Agricultural Economics from Purdue University, joined the Agricultural Economics staff at the Alabama Polytechnic Institute on August 1, 1956, as Associate Professor and Associate Agricultural Economist. He will teach and do research work in farm management.

GEORGE J. CONNEMAN, JR., joined the staff at Cornell University on September 15. His major assignment is in farm management with special work on the expanded program in farm and home management. His title is Farm Management Specialist.

DANA G. DALRYMPLE joined the staff of the University of Connecticut in September as Extension Economist in fruit marketing. He received his M.S. in Agricultural Economics from Cornell University and has served as Executive Secretary of the New York Peach Grower's Association. He recently returned from a 6-months trip to Greece with the Cornell United Religious Work Group.

JOE E. DAVIS transferred in October from the Production Economics Research Branch, ARS, to the Program Analysis Branch, Oils and Peanut Division, Commodity Stabilization Service.

MILTON E. DECHERD, JR., has returned from the armed services to his position in the Cotton and Oilseeds Branch of Farmer Cooperative Service.

GEORGE A. ECKER, who received an M.S. from the University of Connecticut in 1948, has joined the staff at the University as Extension Farm Management Specialist. Mr. Ecker formerly worked with the Grange League Federation and has farmed for the past eight years.

VANCE W. EDMONDSON joined Texas A & M College on September 1, 1956, after completing the requirements of the Ph.D. at Cornell University. His present responsibility is teaching and research in the field of farm management.

CARLOS C. ERWIN transferred from his position as Assistant Economist in agricultural marketing in the Kentucky Agricultural Experiment Station to the College of Commerce, University of Kentucky, where he will teach courses in economic history.

DONALD E. FARRIS has joined the staff at North Carolina State College as Extension Fruit and Vegetable Marketing Specialist.

DUANE C. FEE has joined the staff of the Production Economics Research Branch on a temporary basis. He is stationed at Ames, Iowa, where he is working on economic problems of local watershed organization.

JOHN FERRIS has been appointed to an extension position in price analysis and local price forecasting at Michigan State University. He recently completed the course requirements for the Ph.D.

DARRELL F. FIENUP, formerly Assistant Professor, University of Kentucky, has been appointed Research Associate, Department of Agricultural Economics, University of Minnesota.

PAUL J. FINDLEN has accepted a position in the Foreign Agricultural Service of the United States Department of Agriculture. The first two-year assignment will be Assistant Agricultural Attache in Rome, Italy, working with W. Ray Ogg.

RENE FORTIER, Economics Division, Canada Department of Agriculture, who carried on post-graduate work at the University of Vermont during 1955-56, is continuing his studies at the University of Connecticut.

DONALD K. FREEBAIRN is employed in Mexico by the Rockefeller Foundation to initiate research in Agricultural Economics for their Agricultural Program. He recently completed his work for the Ph.D. degree at Cornell.

WALTER FUHRIMAN, loaned by the Bureau of Indian Affairs, has been temporarily added to the staff of the Production Economics Research Branch, ARS, to work on a study recently initiated in the Columbia Basin area of Washington.

JOE E. FUQUA received the M.S.A. degree from the University of Kentucky in August 1956 and has been appointed Assistant Economist in the Kentucky Agricultural Experiment Station. His thesis was on costs of operating machinery in the harvesting of farm products.

ALAN F. FURMAN has transferred from the Soil Conservation Service to the Production Economics Research Branch, ARS. Mr. Furman, who is stationed at Albuquerque, New Mexico, will help to evaluate the pilot watershed programs installed by SCS in New Mexico.

LEON GAROIN of Oregon City, Oregon, has been appointed Extension Specialist in Fruit and Vegetable Marketing at the University of Wisconsin beginning in November 1956.

JOSEPH GARTNER has been appointed Extension Associate in the Department of Economics and Sociology at Iowa State College to work on a project on market information for consumers. Mr. Gartner holds an M.S. degree from the University of New Hampshire and has more recently been engaged in marketing work at the University of Rhode Island.

VARGE GILCHRIST, of the Saskatchewan office of the Economics Division, Canada Department of Agriculture, is continuing his post-graduate studies at the Oregon State College of Agriculture.

RICHARD J. GOODMAN, former graduate student in agricultural economics at the North Dakota Agricultural College, was appointed research Instructor in Dairy Marketing effective September 15, 1956.

JAMES R. GRAY, Agricultural Economist with the Production Economics Branch, ARS, will return in February 1957 to his cooperative work with the Agricultural Economics Department of New Mexico A & M.

W. SMITH GRIEG has been appointed Assistant Professor (Extension) at Michigan State University. He will work primarily in retailer education. Until January 1 he was doing fruit and vegetable research in the AMS.

ALBERT N. HALTER has received the Ph.D. degree from Michigan State University and accepted a teaching and research position in Agricultural Economics at the University of Kentucky. He will work in the field of production economics.

DALE HATHAWAY has returned to Michigan State University, having completed a year of work with the Council of Economic Advisers.

WILLIAM R. HENRY has joined the staff of North Carolina State College as Assistant Professor of Agricultural Economics.

VIRGIL HERRICK, Production Economics Research Branch, ARS, transferred from the St. Paul office to the Washington office, where he will continue his work in the field of watershed organization.

ROBERT L. HOLLAND joined Texas A & M College October 1, 1956. He is serving as a Cooperative Agent with the U. S. Department of Agriculture and is doing research in wool marketing. He was formerly with the North Carolina Agricultural Extension Service and a student in the Graduate School at the University of Tennessee.

DAVID HOPPER, who completed the requirements for his Ph.D. at Cornell University, has been appointed to the staff of the Department of Agricultural Economics, Ontario Agricultural College, Guelph.

S. AMYE HOTTEL, a recent graduate of the University of Maryland, has joined the staff of the Production Economics Research Branch, ARS. Miss Hottel will work on the river basin program.

S. CLAUDE HUDSON, who was on leave of absence from the Economics Division, Canada Department of Agriculture, during 1955-56 to carry out a technical assistance assignment under FAO as Advisor to the Government of Egypt on the Marketing of Agricultural Products, has been appointed Assistant Director, Agriculture and Fisheries Branch, Department of Trade and Commerce, Ottawa.

RUFUS B. HUGHES, JR., resigned his position as Associate Agricultural Economist at University of Tennessee to accept a position with the University of Arkansas.

LOIS HUTCHISON transferred from the Bureau of the Census to the staff of the Production Economics Research Branch, ARS. Mrs. Hutchison, in her capacity as Analytical Statistician, will work on land values.

LUTHER H. KELLER joined the Department of Agricultural Economics as Assistant Economist in the Kentucky Agricultural Experiment Station on September 1, 1956. He will work in the field of farm management. He formerly was Assistant Economist at the University of Tennessee.

JACK L. KNETSCH joined the Agricultural Economics Branch, Tennessee Valley Authority, in October as agricultural economist. His work will be mainly in the field of water use and irrigation economics.

W. J. LANHAM recently joined the Production Economics Research Branch, Agricultural Research Service, USDA, as an Agricultural Economist and stationed at Clemson College.

ELMER W. LEARN who received the Ph.D. degree at Pennsylvania State University in January, 1956, has been appointed Research Associate, Department of Agricultural Economics, University of Minnesota.

DEANE LEE has joined the University of Massachusetts as Assistant Agricultural Economist.

LAWRENCE A. LEONARD, formerly with the Garrett Corporation of Los Angeles, California, has joined the staff of the Production Economics Research Branch, ARS, where he will work on farm taxation.

NELSON L. LERAY recently transferred from the Foreign Agricultural Service to the Production Economics Research Branch, ARS. He will work on manpower phases of the rural development program.

CARL B. LEWIS, formerly a member of the research staff of the Federal Reserve Bank of Kansas City, has joined the staff of the Production Economics Research Branch, ARS, at Manhattan, Kansas.

E. H. LUEBKE, Associate Agricultural Economist, returned to his duties at the University of Tennessee October 1, after a year's leave spent in study toward the Ph.D. degree at the University of Florida.

BRUCE MACDONALD, has transferred from the Economics Division to the Administration Service, Canada Department of Agriculture, as technical director of the machine tabulation unit.

DAVID L. MACFARLANE, after a year at Cambridge University, has returned to Macdonald College, McGill University, where he is Head of the Department of Agricultural Economics.

ANITA MCCORMICK has accepted a position as Extension Specialist in Marketing Information for Consumers on the Regional Consumer Information Project at Cincinnati, Ohio, effective January 1, 1957. Miss McCormick recently obtained her master's degree in agricultural economics at Ohio State University and was formerly Home Demonstration Agent in Lake County, Ohio.

PAUL MCMAINS, formerly employed by the old Bureau of Agricultural Economics and the Bureau of Reclamation, has been added to the staff of the Production Economics Research Branch, ARS, to work on a study recently initiated in the Columbia Basin area of Washington.

JOSEPH F. METZ, JR., joined the staff at Cornell University on October 1, 1956 as Assistant Professor of Marketing. He received a Ph.D. degree at Cornell in September.

C. CLYDE MITCHELL, Professor of Agricultural Economics at the University of Nebraska, is now with the FAO in Mexico City, Mexico.

WILLIAM J. MONROE, formerly employed by the Carnation Company at Spokane, Washington, has joined the staff of the Dairy Branch, Farmer Cooperative Service, to do research in milk marketing.

DONALD S. MOORE joined the Texas A & M College Staff, October 1, 1956, to do research in farm management and farm credit as related to farm adjustments. Mr. Moore holds a degree from Oklahoma A & M College and has served with the Economics and Credit Analysis Division of the Farm Credit Administration in Washington, D.C.

PAUL MULLER, formerly with the Economics Division, Canada Department of Agriculture, is now an economist with Monsanto "Canada" Limited, Montreal.

YAIR MUNDLAK joined the staff of Agricultural Economics at the University of California at Berkeley as Associate Specialist in the Experiment Station. He was formerly a research economist at Stanford Institute, Menlo Park, California.

JOHN NAIRN joined the staff at the State College of Washington July 16, 1956 as a Junior Agricultural Economist. He received his M.S. degree from Oregon State College in January 1955.

ALFRED C. NEAL, former First Vice President of the Federal Reserve Bank of

Boston, has been appointed to the newly created post of President of the Committee for Economic Development. Mr. Neal, a former professor of Economics at Brown University, has been in charge of research activities at the Federal Reserve Bank in Boston since 1943.

MICHAEL NELSON, who recently completed work for a Ph.D. at Oregon State College, accepted a position with the Stanford Research Institute at Palo Alto, California, effective January 1.

G. ALLEN O'BRIEN, formerly with the Economics Division, Canada Department of Agriculture, and more recently in private business in Shediac, New Brunswick, has accepted an appointment as Assistant Manager of the Canadian Co-operative Wool Growers, Toronto.

FRANK ORAZEM accepted a position as Assistant Professor with the Department of Economics and Sociology, Kansas State College, December 15, 1956. Dr. Orazem's immediate duties will be with agricultural policy but later he will develop research relating to the use of resources in western Kansas.

HARRY T. OSHIMA has been appointed Acting Assistant Economist in the Food Research Institute to undertake a comparative study of the contributions of agriculture to the increase of gross national product of three sugar-producing islands, Cuba, Puerto Rico, and Hawaii. The investigation is being sponsored by the Food Research Institute and the Economics Department of Stanford University, with the aid of a grant from the Committee for Economic Growth of the Social Science Research Council.

DONALD G. PARIS received the M.S.A. degree from the University of Kentucky in August 1956 and has been appointed Assistant Economist in the Kentucky Agricultural Experiment Station. His thesis dealt with relative costs of cage and floor arrangements for laying hens.

LEO PASCHAL has transferred from the Production Economics Research Branch, ARS, to the International Cooperation Administration for an assignment to La Paz, Bolivia, where he will be Economic Advisor to the Director of the Agricultural Resources Division of the U. S. Operations Mission to Bolivia and to the Bolivian Minister of Agriculture.

E. A. PERREGAUX has returned from a year-and-a-half assignment as Chief of the Agriculture Division, U. S. Department of State, Mission to Laos. Dr. Perregaux retired from the University of Connecticut in 1955 as Head of the Department of Agricultural Economics and Farm Management.

JOHN C. REDMAN is on sabbatical leave from the University of Kentucky to do postdoctorate study in economics at the University of Chicago. He was awarded a grant from the Social Science Research Council effective September 1, 1956.

ROBERT ROGERS is on leave from the Production Economics Research Branch, ARS, to complete his work toward a Ph.D. at the University of Chicago.

R. OTIS RUSSELL was recently appointed Assistant in Agricultural Economics at the Alabama Polytechnic Institute. He will do research work in marketing and graduate study in the same area.

JAMES A. SEAGRAVES has joined the staff at North Carolina State College as Assistant Professor of Agricultural Economics.

CLAUD L. SCROGGS accepted an appointment on September 1 as Assistant Agricultural Economist and Assistant Professor in Agricultural Economics at the University of Tennessee. Dr. Scroggs did some graduate work at the University of Missouri and received his Ph.D. from North Carolina State College. The three previous years have been spent in self-employment as a consulting economist to Agricultural Industries in Washington, D.C.

S. CABELL SHULL, Associate Professor of Agricultural Economics, University of Maryland, is on leave and is serving as Assistant Agricultural Attaché in London, England.

JOHN B. SJO, who was on leave to take graduate work toward the Ph.D. degree at Michigan State University, resumed his position as Instructor in Agricultural Economics in the Department of Economics and Sociology at Kansas State College, September 1, 1956.

MILTON H. STEINMUELLER accepted a position with the Production Economics Research Branch on November 1. He is stationed at Michigan State University to help organize and conduct research on problems of low farm income. He was formerly at the State College of Washington and has recently completed the course work for the doctorate at Michigan State University.

RANDALL STELLY became a member of the staff of Texas A & M College, October 1, 1956. He is conducting research in dairy and lamb marketing. He completed the requirements for the Ph.D. degree at Louisiana State University, June 1956. Stelly served formerly as an Agricultural Economist on the staff of the International Cooperation Administration.

JAMES R. STRAIN has been appointed Extension Specialist in Dairy Marketing in the Department of Economics and Sociology at Iowa State College. Mr. Strain received his M.S. degree from Purdue University and is a candidate for the Ph.D. degree at Oregon State College.

DANIEL STURT has been appointed District Extension Director of Extension and Continuing Education Programs in the Upper Peninsula of Michigan effective January 1. He will reside in Marquette, Michigan.

C. C. TAYLOR joined the staff of the Department of Agricultural Economics, University of Maryland, September 1, as Visiting Professor. Dr. Taylor is retired from the State Department after completing about 30 years in foreign service.

JACK C. THOMPSON joined the Department of Agricultural Economics at the College of Agriculture, the University of Georgia, on August 1, 1956, in the capacity of Associate Professor of Marketing.

JACK L. TURNER, who recently received an M.S. degree in horticulture, has been appointed Assistant in Agricultural Economics at the Alabama Polytechnic Institute. He will do research in connection with marketing tests and consumer acceptance of newly developed horticultural products.

ERWIN O. ULLRICH, JR., has joined the Western Field Staff of the Production Economics Research Branch, ARS, at Fargo, North Dakota, where he will be engaged in Production Economics Research in cooperation with the North Dakota Agricultural Experiment Station. Mr. Ullrich received his M.S. Degree from Colorado A & M College last summer.

RUBY P. UZZLE has joined the staff at North Carolina College. Mrs. Uzzle will serve as Extension Consumer Marketing Specialist.

DAVID L. WILSON has joined the Upper Colorado River survey staff of the Production Economics Research Branch, ARS, at Salt Lake City.

WALTER L. WILSON joined the agricultural economics staff at North Dakota Agricultural College, September 15, 1956. He is writing a thesis for the doctorate at the University of Illinois, and will do teaching and research in farm management and production economics.

HARRY WOLTMAN joined the staff of agricultural economics at the University of California at Berkeley as Associate Specialist in the Experiment Station. He was formerly a research economist at Stanford Institute, Menlo, Park, California.

CLYDE E. WOODALL, who recently received his M.S. degree from Clemson College, joined the agricultural economics staff at Clemson on September 1, 1956 with the rank of Assistant Agricultural Economist.

GLYN E. WOOLLAM, formerly with the Economics Division, Canada Department of Agriculture, has been appointed chief, Food and Agriculture Division, Agriculture and Fisheries Branch, Department of Trade and Commerce, Ottawa.

JOHN W. WYSONG has joined the farm management research and extension staff at the University of Maryland. He completed the requirements for the Ph.D. degree at Cornell in September.

JOHN M. ZIMMER, who recently received his M.S. degree from North Dakota Agricultural College, has joined the Western Field Staff of the Production Economics Research Branch, ARS, at Fargo, North Dakota.

SOUTHERN REGIONAL GRADUATE SUMMER SESSION IN STATISTICS

The fourth Southern Regional Graduate Summer Session in Statistics will be held during the summer of 1957 from June 12 through July 20 at the Virginia Polytechnic Institute, Blacksburg, Virginia. The three previous sessions were held at the Virginia Polytechnic Institute, the University of Florida, and North Carolina State College in that order. In 1958, the summer session will be held at Oklahoma Agricultural and Mechanical College.

Each annual summer session lasts six weeks and each course offered carries approximately five quarter hours of graduate credit. The program may be entered at any session and consecutive courses will be offered in successive summers. The summer work in statistics may be applied towards residence requirements at any one of the cooperating institutions, as well as certain other institutions, in partial fulfillment of residence requirements for graduate degrees.

The faculty for the 1957 session at the Virginia Polytechnic Institute will include Evan J. Williams, Principal Research Officer, Commonwealth Scientific and Research Organization, Division of Mathematical Statistics, Melbourne, Australia; Daniel B. DeLury, Director of Statistics, Ontario Research Foundation, Toronto, Canada; J. L. McHugh, Director, Virginia Fisheries Laboratories; and the following staff members from the Virginia Polytechnic Institute: Willard O. Ash, L. S. Brenna, Ralph A. Bradley, C. W. Clunies-Ross, John E. Freund, Rudolf J. Freund, Boyd Harshbarger, Clyde Y. Kramer, and R. Lowell Wine.

Of particular interest at this summer session will be the lectures by D. B. DeLury on the Sampling of Biological Populations. This course will concern itself with the study of statistics of biological populations with specific reference to marine research. E. J. Williams will give a course on the Analysis of Variance from the regression point of view with generalizations to multivariate analysis. R. A. Bradley will be giving a course on Rank Order Statistics and will include some of the more recent research. J. E. Freund will give a course in Stochastic Processes, with particular reference to engineering applications. He will present many of the more recent advance in this field as well as his own research. The other graduate courses will include Probability by C. W. Clunies-Ross, Statistical Inference by W. O. Ash, Theory of Least Squares by R. L. Wine, Statistical Methods by C. Y. Kramer, Engineering Statistics by L. S. Brenna, and Sampling by R. J. Freund. Courses in Statistical Methods and Sampling are especially applicable to social science students. Seminars will be conducted each afternoon Monday through Thursday from 3:00 to 4:30.

The total tuition fee will be $38.00 for the six-week term. Doctoral courtesy will be offered to those holding doctoral degrees. Living and other expenses at the Virginia Polytechnic Institute are reasonable. The Virginia Polytechnic Institute is located at Blacksburg, Virginia, on the scenic Allegheny Mountain plateau 2100 feet above sea level. The summer climate is delightful.

Inquiries should be addressed to Boyd Harshbarger, Head, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

THE AMERICAN FARM ECONOMIC ASSOCIATION AWARDS FOR RESEARCH in Agricultural Economics 1957

To recognize and encourage meritorious research in agricultural economics, seven awards of $250 each will be presented in 1957 by the American Farm Economic Association. In addition, three awards will be presented for papers contributed by graduate students.

Selection for the awards will be made from published research, Ph.D. theses, and papers submitted for consideration in accordance with the procedures outlined below.

AWARDS FOR PUBLISHED RESEARCH

1. Three $250 awards, each in a different field of agricultural economics, will be made for publications including bulletins, articles, and pamphlets (books are ineligible) classified in the following categories:
(a) Farm management and production economics
(b) Agricultural marketing
(c) Agricultural prices
(d) Agricultural finance
(e) Land and water economics and conservation
(f) Theory and methodology
(g) Agricultural policy
(h) General agricultural economics

2. Persons submitting items should indicate the field in which they believe the reports should be classified.

3. Selections will be made from published research bearing the publication date of 1956.

4. Eligible recipients must be less than 41 years of age at the time of publication.

5. Members of the Awards Subcommittee for Published Reports will not be eligible to submit papers of their own.

6. Each published report may receive only one award presented by the American Farm Economics Association in 1957. An entry may, however, be considered as eligible for more than one of the following types of awards: (a) Best article appearing in the JOURNAL OF FARM ECONOMICS; (b) Published reports; and (c) Ph.D. theses.

7. Nine copies are requested of each publication submitted for consideration. Fewer copies will be accepted in such cases as articles appearing in national journals available to the judges. In no event should less than three copies be sent.

8. The Awards Subcommittee for Published Reports will consist of nine persons, in addition to the Chairman, representing the various designated fields. The members of the Subcommittee, all of whom will serve as judges, are:
George E. Brandow, Pennsylvania State University
Max E. Brunk, Cornell University
Marion Clawson, Resources for the Future, Inc.
Earl O. Heady, Iowa State College
W. E. Hendrix, U. S. Department of Agriculture
Sidney S. Hoos, University of California
Herman M. Southworth, U. S. Department of Agriculture
Lawrence W. Witt, Michigan State University

Elmer J. Working, Washington State College

9. Publications should be sent directly to the Chairman of this Subcommittee, James P. Cavin, Statistical and Historical Research Branch, Agricultural Marketing Service, Washington 25, D.C., on or before March 15, 1957.

AWARDS FOR PH.D. THESES

1. Three $250 awards will be made for theses prepared by candidates for the Ph.D. degree in any department of Economics or Agricultural Economics.

2. An entry must be submitted by the head of the department to which the thesis was presented in partial fulfillment of requirements for a degree. No department may submit more than one thesis for consideration.

3. Selections will be made from those presented to a graduate school faculty during the calendar year 1956.

4. A published thesis may be entered in both the published report and thesis classes but will be eligible for only one award.

5. Only one copy of an unpublished thesis will need to be sent to the Committee Chairman for consideration. If 2 or 3 are available it will expedite the judging. All copies will be returned after they have been read by the judges.

6. The Awards Subcommittee for Theses will consist of three persons, in addition to the Chairman. These three persons, all of whom will serve as judges, are:

Kenneth L. Bachman, U. S. Department of Agriculture
George G. Judge, Oklahoma A. & M. College
Geoffrey S. Shepherd, Iowa State College

7. Theses should be sent directly to the Chairman of this Subcommittee, Ronald L. Mighell, Production Economics Research Branch, Agricultural Research Service, Washington 25, D.C., on or before March 15, 1957.

AWARD FOR BEST ARTICLE IN JOURNAL OF FARM ECONOMICS

As has been the practice for a number of years, the Editors and Editorial Council of the JOURNAL OF FARM ECONOMICS will again choose the most outstanding article published in the JOURNAL during the preceding calendar year (in this instance 1956). However, effective this year, the amount of this award has been increased from $100 to $250.

AWARDS FOR PAPERS CONTRIBUTED BY GRADUATE STUDENTS

1. Three awards will be made for papers submitted by graduate students of any department in the United States engaged in training agricultural economists at the graduate level.

2. Each award shall consist of the cash equivalent of round-trip bus fare from the student's graduate institution to the 1957 Annual Meetings at Lake Junaluska, North Carolina; a $25 subsistence allotment; and 100 free reprints of the paper as published in the Proceedings Number of the JOURNAL OF FARM ECONOMICS.

3. The student shall be free to choose the subject for his paper, which must, however, be in the area of agricultural economics and shall be limited to 20 minutes' reading time or 9-10 pages of double-spaced typed manuscript.

4. Each department may submit only one paper, selected by a committee of that department. Papers with joint authors are not acceptable.

5. Department heads shall decide which persons qualify as "graduate students." However, full-time staff members working on a degree at their home institutions shall not be eligible.

6. Each department head shall notify Chairman Gordon Ball of Iowa State College by March 15, 1957, if his department expects to submit a graduate student's paper.

7. The winners of the three awards will be notified by June 15, and will be expected to read their papers at the Annual Meetings at Lake Junaluska. Their papers will be published as part of the Proceedings of the 1957 Annual Meetings.

8. The Awards Subcommittee for Graduate Students' Contributed Papers will consist of four persons, in addition to the Chairman, all of whom will serve as judges:

R. J. Hildreth, Texas A. & M. College
William O. Jones, Stanford University
Frank Miller, University of Missouri
W. H. Pierce, North Carolina State College

9. Five typed copies of each paper shall be sent directly by departments to the Chairman of this Subcommittee, Gordon Ball, Department of Economics and Sociology, Iowa State College, Ames, Iowa, on or before May 15, 1957.

* * * *

Announcements of the 1957 awards will be made at the 1957 annual meeting of the American Farm Economic Association. Names of the recipients of the 1956 awards appear in the Proceedings Issue of the JOURNAL OF FARM ECONOMICS.

These awards are financed from a fund donated by individuals and firms interested in advancing research and scholarship in Agricultural Economics. The funds and programs are administered by the American Farm Economic Association. General inquiries, and requests for additional copies of this announcement, should be directed to the Chairman of the Awards Committee, William H. Nicholls, Box 1819, Vanderbilt University, Nashville 5, Tenn.

AFEA Employment Service Procedure

The AFEA Employment Committee is mailing personal data forms and employer forms to all land grant colleges and universities and the United States Department of Agriculture. The personal data forms should be distributed to all Association members. Those who do not receive a form through these channels may do so by writing to Norman Nybroten, Chairman, AFEA Employment Committee, Department of Agricultural Economics, West Virginia University, Morgantown, West Virginia. The chairman of the Committee will act as liaison between prospective employers and employees. The forms contain further instructions. If the returns seem to warrant such procedure, coded lists of vacancies and applications will be compiled for distribution. At least for the present, there will be no charge for the service.

AGRICULTURAL HISTORY

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RURAL SOCIOLOGY

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